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RECOMMENDATIONS for ANALYZING ACCIDENTS under the NATIONAL ENVIRONMENTAL POLICY ACT

July 2002

U.S. Department of Energy
Environment, Safety and Health
Office of NEPA Policy and Compliance

DOEF 1325.8
(8-89)
EFG (07-90)

United States Government **Department of Energy**

memorandum

DATE: July 10, 2002

REPLY TO
ATTN OF: Office of NEPA Policy and Compliance, EH-42

SUBJECT: Final Guidance on Accident Analyses under NEPA

TO: Secretarial Officers and Heads of Field Organizations (list attached)

I am pleased to provide the attached guidance entitled *Recommendations for Analyzing Accidents under NEPA,* which my staff prepared with help from your National Environmental Policy Act (NEPA) Compliance Officers and in consultation with the Office of General Counsel. We expect that this guidance will foster consistency among NEPA documents while providing document preparers with substantial flexibility in approach.

The guidance clarifies and supplements *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements,* which the Office of Environment, Safety and Health issued in May 1993. This new guidance focuses on principles of accident analyses under NEPA and presumes that accident analysts have appropriate technical knowledge and skills. The guidance addresses many key aspects of analysis but is not comprehensive; we intend to issue further topical supplements as appropriate.

In preparing this final guidance, we responded to comments from NEPA Compliance Officers and other members of the Department's NEPA community on draft guidance that we circulated in April 2000. We provided NEPA Compliance Officers with a detailed response to comments on the draft guidance and an opportunity, in June 2002, to review a preliminary draft of the final guidance; we have considered their recent comments on the preliminary draft of the final guidance. Questions regarding *Recommendations for Analyzing Accidents under NEPA* should be directed to Eric Cohen in the Office of NEPA Policy and Compliance at 202-586-7684 (eric.cohen@eh.doe.gov).

Assistant Secretary
Environment, Safety and Health

Attachment
cc: Distribution List

Recommendations

for

Analyzing Accidents under NEPA

Contents

Recommendations

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Analyzing Accidents under NEPA

1.0 Introduction

This paper provides guidance for preparing accident analyses in Department of Energy (DOE) National Environmental Policy Act (NEPA) environmental impact statements (EISs) and environmental assessments (EAs). This guidance clarifies and supplements *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (*Recommendations*), which the Office of Environment, Safety and Health issued in May 1993 (DOE, 1993). For convenience, Section 6.4 (accident analysis) of *Recommendations* is attached to this guidance (Attachment 3).

This guidance addresses NEPA policy and requirements related to accident analyses in NEPA documents, and is targeted primarily to those responsible for preparing NEPA documents, including NEPA Document Managers, NEPA Compliance Officers, and document reviewers. This guidance does not provide detailed technical instructions for analysis of accidents; it presumes that accident analysts have appropriate technical knowledge and skills.

Further, this guidance addresses only certain aspects of accident analyses. The Office of Environment, Safety and Health intends to issue topical supplements to this guidance.

As with all aspects of environmental documentation, appropriate security reviews of accident analyses under NEPA should be conducted to determine whether public access to information should be limited.

1.1 Definition

An accident is an unplanned event or sequence of events that results in undesirable consequences. Accidents may be caused by equipment malfunction, human error, or natural phenomena.

1.2 Purpose

Documents prepared under NEPA should inform the decision maker and the public about the chances that reasonably foreseeable accidents associated with proposed actions and alternatives could occur, and about their potential adverse consequences. The term “reasonably foreseeable” extends to events that may have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason. [Council on Environmental Quality (CEQ) NEPA Regulations, 40 CFR 1502.22]

Accident analyses are necessary for a reasoned choice among the proposed action and alternatives and appropriate consideration of mitigation measures. Accident analyses in NEPA documents can provide estimates of the magnitude of risk[1] that the proposed action and alternatives would present and a comparison of risk among the proposed action and alternatives.

1.3 Sliding Scale

Consistent with the principle that impacts be discussed in proportion to their significance (40 CFR 1502.2(b)), DOE NEPA document preparers should use a sliding scale approach (as described in *Recommendations*) to accident analyses. While this paper provides general principles to guide the development of accident analyses for DOE NEPA documents, these principles do not reduce to a "cookbook" approach. Rather, DOE document preparers must apply considerable judgment to determine the appropriate scope and analytical requirements of accident analyses for each DOE NEPA document. For example, preparers will need to determine the appropriate range and number of accident scenarios to consider, and the level of analytical detail and degree of conservatism that should be applied. A sliding scale approach is particularly applicable in making these determinations.

Key factors to consider in applying a sliding scale approach to accident analyses include:

- probability that accidents will occur
- severity of the potential accident consequences
- context of the proposed action and alternatives
- degree of uncertainty regarding the analyses (e.g., whether sufficient engineering design information is available to support detailed analysis) and
- level of technical controversy regarding the potential impacts.

[1] Although "risk" is a term that can be used to express the general concept that an adverse effect could occur, in quantitative assessments it is generally understood within DOE to refer to the numeric product of the probability and consequences. "Risk" is used in the latter way in this guidance. When risk cannot be quantified, it is appropriate to discuss risk qualitatively in terms of the probability and potential consequences.

2.0 Overview

An accident is an event or sequence of events that is not intended to happen, and indeed may not happen during the course of operations. The probability that a given accident will occur within a given time frame can be estimated. The probability of occurrence is expressed as a number between 0 (no chance of occurring) and 1 (certain to occur). Alternatively, instead of probability of occurrence, one can specify the frequency of occurrence (e.g., once in 200 years, which also can be expressed as 0.005 times per year).

An accident *scenario* is the sequence of events, starting with an *initiating event,* that makes up the "accident." It is important to distinguish the probability (or frequency) of the initiating event from that of the entire scenario; the probability of the entire scenario is of primary interest in NEPA accident analyses because it expresses the chance (or rate) that the environmental consequences could occur.

In this guidance the environmental consequences of accidents are effects (impacts) on human health and the environment. In discussing an accident's effects on human health in NEPA documents, it is both conventional and adequately informative to consider three categories of people: involved workers, noninvolved workers, and the general public. For each of these categories, evaluate impacts on the maximally exposed individuals and the collective impact to each population group. As noted in *Recommendations*, the analysis of human health effects should be carried to completion. That is, do not report only doses (radiological and chemical, as appropriate) to individuals and groups, which are neither health effects nor environmental impacts. Rather, identify and quantify, when appropriate, potential health effects (e.g., number of latent cancer fatalities).

Evaluate impacts for: involved workers, noninvolved workers, and the general public.

Evaluate impacts on the maximally exposed individual in each category and the collective impact to each population.

The environment includes biota and environmental media, such as land and water.

In the context of analyzing accidents, the environment includes biota and environmental media, such as land and water, which may become contaminated as the result of an accident. This guidance refers to effects on biota as ecological impacts.

DOE's accident analyses under NEPA should consider both radiological and non-radiological hazards, commensurate with significance. Some DOE NEPA documents have focused too much on potential radiological accidents in comparison with non-radiological accidents. In many cases the risks associated with potential releases of toxic chemicals may be far greater than radiological risks, and should be analyzed accordingly. For example, many DOE sites provide their own potable or wastewater treatment, which can require storing significant quantities of chlorine, an extremely hazardous substance. *Recommendations* (Section 6.2, "Human Health Effects") discusses the analysis of effects from chemical exposure.

With respect to radiological risks, note that the discussion of *Human Health Effects* in *Recommendations* focuses on the effects of low doses of radiation. However, an accident analysis may involve both high and low radiation doses. High absorbed doses (hundreds of rad) delivered over a short period of time may result in a risk of a prompt fatality from non-cancer syndromes (e.g., gastrointestinal syndrome, pulmonary syndrome, or hematopoietic syndrome). Evans et al. (NRC, 1993) provides methods for estimating these early mortality risks.

Consider both radiological and non-radiological hazards, commensurate with significance.

Use appropriate current dose-to-risk conversion factors that have been adopted by cognizant health and environmental protection agencies.

In addition, the appropriate dose-to-risk conversion factors for estimating impacts at high doses (between about 25 and 100 rem) may not be appropriate at lower doses (less than about 25 rem). For example, the high-dose-to-risk conversion factor in Federal Guidance Report No. 13 (EPA, 1999) is 1.1×10^{-3} fatal cancers per rem; the corresponding low-dose-to-risk conversion factor is 6×10^{-4} fatal cancers per rem. As discussed in *Recommendations*, use current dose-to-risk conversion factors that have been adopted by cognizant health and environmental protection agencies, such as the Environmental Protection Agency and the Nuclear Regulatory Commission. When uncertain, consult the Office of Environment, Safety and Health.

In presenting accident analysis results, be clear about the types of exposure scenarios analyzed to avoid confusion. For example, radiological accident scenarios often involve inhaled or ingested long-lived radioactive materials that result in a persistent dose rate to a person throughout his/her lifetime, the accumulation of which is expressed as a committed effective dose equivalent. The reported committed effective dose equivalent may be a large number (e.g., several hundred rem) that may appear to be a high *acute absorbed* dose. In presenting the results for such scenarios it is important to associate the estimate of committed effective dose equivalent with a time period starting from the exposure event and continuing through the person's lifetime.

3.0 Accident Scenarios and Associated Probabilities/Frequencies

3.1 Scenario Development

Range of Accident Scenarios

The key to informative accident analyses is to develop realistic accident scenarios that address a reasonable range of event probabilities and consequences. The set of accident scenarios considered should serve to inform the decision maker and the public of the accident risks associated with a proposed action and alternatives. DOE should consider accident scenarios that represent the range or "spectrum" of reasonably foreseeable accidents, including low probability/high consequence accidents and higher probability/(usually) lower consequence accidents. (Attachment 1 discusses a related issue, namely intentional destructive acts.)

Analyze *maximum reasonably foreseeable accidents* to represent potential accidents at the high consequence end of the spectrum. A maximum reasonably foreseeable accident is an accident with the most severe consequences that can reasonably be expected to occur for a given proposal.[2] Such accidents usually have very low probabilities of occurrence. As noted above, however, the accident analysis normally should not end with the analysis of maximum reasonably foreseeable accidents.[3]

For most proposals, DOE also should analyze other accidents in the "spectrum" because they may contribute importantly to, or even dominate, the accident risks. In some cases other accidents along the spectrum with lesser consequences than the maximum reasonably foreseeable accident may have an associated significant risk, perhaps a greater risk than the maximum reasonably foreseeable accident. The Cerro Grande fire (see text box on page 8) is an example of such an accident. Analyze a sufficient range of accidents to adequately inform about the accident risks of the proposed action and alternatives.

Analyze the consequences of maximum reasonably foreseeable accidents.

Analyze a sufficient range of accidents to adequately inform about the accident risks of a proposed action and alternatives.

"Bounding" approaches may be used to streamline analyses and account for uncertainty, but tend to mask differences among alternatives.

In developing accident scenarios, some document preparers compensate for analytical uncertainty by using conservative or "bounding" approaches that tend to overestimate potential impacts. Bounding approaches based on conservative assumptions may have several potential benefits, such as streamlining an analysis when there are many uncertainties and avoiding the need to prepare more realistic analyses when not warranted. Further, bounding analyses may be more defensible than more realistic approaches because they are unlikely to underestimate potential accident consequences. On the other hand, bounding analyses may mask differences among alternatives and be less informative about the potential need for mitigation. Also, excessive conservatism may result in a misleading presentation of accident risks.

Because one purpose of NEPA analysis is to inform the public, consider analyzing an accident scenario in which the public has expressed a keen interest, even when the scenario is not

[2] Maximum reasonably foreseeable accidents are not the same as "worst-case" accidents, which almost always include scenarios so remote or speculative that they are not reasonably foreseeable and not helpful to a decision maker. Analysis of worst-case accidents is not required under NEPA.

[3] An exception to these general guidelines may exist in circumstances where the consequences of the maximum reasonably foreseeable accident are very small. In that case, analyzing only the maximum reasonably foreseeable accident may provide sufficient information regarding the accident risks of the proposal.

reasonably foreseeable. Do not analyze physically impossible accidents, however. Always explain why a scenario of interest to the public was excluded from analysis.

Scenario Probabilities

An accident scenario involves a postulated initiating event followed by a sequence of other events or circumstances that result in adverse consequences. If these subsequent events always occur when the initiating event occurs (i.e., the subsequent events have a conditional probability of 1, given that the initiating event occurs), then the probability (or frequency) of the entire accident scenario is that of the initiating event. Otherwise, the scenario probability would be the product of the initiating event probability and the conditional probabilities of the subsequent (presumed independent for purposes here) events, given that the initiating event has occurred.

Conservatisms

In accident analyses, as with many aspects of environmental analysis in NEPA documents, preparers need to make judgments about the appropriate degree of conservatism to apply. In applying the sliding scale principle to making such judgments, preparers should consider the fundamental purposes of the analysis as discussed above, the degree of uncertainty regarding the proposal and its potential impacts (see further discussion of uncertainty below), and the degree of technical controversy. Accident analyses under NEPA should be realistic enough to be informative and technically defensible.

Consistent with CEQ regulations, avoid scenarios that are based on pure conjecture (40 CFR 1502.22). Specifically, avoid compounding conservatisms evaluating a scenario by using conservative values for multiple parameters will yield unrealistic results.

For example, in air dispersion modeling, it is nearly always unrealistic to assume only extremely unfavorable meteorological conditions; prevailing (median) meteorological conditions generally should be used. In exceptional cases (e.g., when there is heightened controversy regarding accident risks or to enable a comparison with analysis in another document), it would be appropriate to estimate and present accident consequences for both median conditions and unfavorable conditions. Median conditions are often defined by using 50% meteorology, which represents plume concentrations that are not exceeded 50% of the time for a given direction and distance or receptor location, and are often characterized by stability class D and moderate wind speeds. (Fifty percent meteorology should not be confused with annual average meteorology. The latter is appropriate for estimating the impacts of normal operations or expected occurrences, but is generally not appropriate for estimating the consequences of accidents.) Unfavorable conditions

Apply the sliding-scale principle in making judgments about the appropriate degree of conservatism.

Avoid scenarios that are based on pure conjecture (40 CFR 1502.22).

are often defined using 95% meteorology,[4] which represents plume concentrations that are not exceeded 95% of the time, and are often characterized by stability class F and low wind speeds. (However, when estimating plume concentrations from elevated releases, both median and unfavorable conditions may be characterized by other combinations of stability class and wind speed.)

Similarly, using estimates of plume centerline concentrations may be appropriate for evaluating impacts to maximally exposed individuals, but would not be appropriate for evaluating population impacts (would overestimate impacts); sector-averaged plume concentrations would yield more realistic results for population impacts. In other words, it would be unrealistic to assume that everyone in a population received the same exposure as the maximally exposed individual. (As appropriate for the constituents released during an accident, realistic plume concentrations may be based on time-integrated concentrations or peak concentrations, or they may incorporate averaging times.)

Applying these principles to choices of other key parameters will help avoid unrealistic results.

[Note: It would never be appropriate to assume only extremely unfavorable meteorological conditions for the purpose of reducing estimates of the probability of an otherwise credible accident scenario, and then fail to analyze the scenario at all because, by taking account of the probability of unfavorable meteorological conditions, estimates of the overall scenario probability are then judged to be so low as to be not reasonably foreseeable. Although meteorological conditions affect the consequences of accidents, the probability of meteorological conditions assumed in air dispersion modeling should not be included in estimates of the probability of an accident scenario analyzed in a NEPA document. In those cases when document preparers choose to present accident consequence estimates based on both median and unfavorable meteorological conditions, it would be appropriate to note that the unfavorable conditions would be less likely to occur.]

3.2 Frequency

"Frequency" refers generally to the *rate* at which events occur or are expected to occur over some measured interval (e.g., number of events per unit time, number of events per operation, or number of events per mile traveled). In this guidance, frequency refers to the number of accident events expected per year. "Return period" is a related concept, applicable to natural phenomena (e.g., earthquakes, storms, high winds, and floods). An event with an expected return period of 100 years (e.g., a 100-year flood) is defined to have a frequency of occurrence of one event per 100 years, or 10^{-2} per year.

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[4] Unfavorable atmospheric conditions also have been defined by 99.5% sector-specific and 95% overall site meteorology [e.g., see Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants (NRC, 1983)]. Ninety-five percent overall site meteorology is different from 95% meteorology in that 95% overall site meteorology is determined based on the distance to receptor locations in all directions, while 95% meteorology is based on a single direction or single receptor location.

Case Study – LANL SWEIS Wildfire Scenario

The accident analysis in the Final Site-wide EIS (SWEIS) for the Los Alamos National Laboratory (LANL) (DOE-EIS/0238, January 1999) helped reduce the consequences of the Cerro Grande wildfire that burned about 9,000 acres (about 30 percent) of LANL, and about 50,000 acres of surrounding land, in May 2000. The SWEIS analysis proved to be realistic – a wildfire scenario analyzed closely mirrored the actual event – and the SWEIS was a helpful resource during and after the fire. Further, the document prompted the Department to take action beforehand to mitigate potential wildfire consequences, which helped protect buildings in the path of the fire from damage. The only serious property damage within LANL was to temporary structures, such as trailers, that were destroyed.

The Draft SWEIS did not analyze a site-wide wildfire scenario. Rather, the Draft SWEIS considered fires at individual facilities but did not analyze such fires in detail because they were bounded by other facility accidents. Comments at a public hearing from a forester at the nearby Santa Fe National Forest and written comments from the Department of the Interior focused attention on wildfire, and the SWEIS team promptly investigated. In view of the high annual probability of a wildfire, estimated in the Final SWEIS at about 0. 1 (once every 10 years), the team determined that potential wildfires were among the risk-dominant accident scenarios for LANL, warranting immediate mitigation measures.

As a result of the SWEIS analysis and the dedication of the document preparation team, mitigation was begun immediately to reduce the wildfire risks at key facilities, including waste facilities at TA-54 and the Weapons Engineering Tritium Facility at TA-16. DOE removed trees and other potential fuel, including replacing wooden pallets with aluminum ones. (See "Los Alamos Site-wide EIS Analyzed Wildfire Impacts, Prompted Mitigation Actions," *Lessons Learned Quarterly Report*, June 2000, page 1, available on the DOE NEPA Web at http://tis.eh.doe.gov/nepa, under NEPA Process Information.)

The potential radiological consequences of a wildfire, as estimated in the Final SWEIS (0.34 LCFs), were small in comparison with those of postulated earthquakes. The SWEIS analyzed several earthquake scenarios, with estimated consequences ranging from about 16 LCFs (moderate event that damages some facilities, estimated to occur once in 350 years) to about 230 LCFs (a very large event that damages all facilities, estimated to occur less than once in about 33,000 years). Accounting for probabilities of occurrence, however, the estimated radiological risks of a wildfire (0.034 LCFs per year) were greater than for the very large earthquake (0.0095 LCFs per year), and less than a moderate earthquake (0.046 LCFs per year).

Moreover, the non-radiological consequences of the Cerro Grande wildfire were devastating for the people impacted. This illustrates that, as with many accident scenarios, a single risk calculation or pathway does not encompass all of the impacts. Importantly, the SWEIS evaluated potential hazards other than radiation exposure. For example, the Final SWEIS supplemented the discussion of radiation-related human health impacts with a discussion of potential chemical releases, loss of protective cover, soil erosion, runoff, effects on biological systems and cultural resources, effects on legacy contaminants, and other consequences of a wildfire.

This case study illustrates several key points, including the importance of:

- Analyzing a sufficient range of accidents to adequately inform about accident risks
- Considering non-radiological impacts
- Using accident analyses to identify potential mitigation measures, and
- Considering input from the public and other government agencies.

While frequency is a useful quantity in accident analyses, it is not a “bottom line” measurement. Rather, the bottom line measurement is the probability that the accident would occur during the lifetime of the proposed action. For example, the probability that an event with a frequency of 1x 10^{-6} per year would occur during an assumed 30-year project lifetime is about 3 x 10^{-5} [about 30 times 10^{-6}].[5] Both frequency (or return period) and the probability of occurrence during the lifetime of the proposed action should be reported in NEPA documents.

Most facilities have operational lifetimes of only several decades. Accident scenarios that have frequencies less than 10^{-6} per year are so unlikely to occur during the life of such facilities that they generally are not important to consider in making decisions about the facilities. Nevertheless, scenarios with frequencies in the range of 10^{-6} to 10^{-7} per year should be considered if the accident consequences may be very large. As a practical matter, scenarios with frequencies less than 10^{-7} per year will rarely need to be examined.

Consider scenarios with frequencies of 10^{-6} to 10^{-7} per year if the consequences may be very large.

Scenarios with frequencies less than 10^{-7} per year rarely need to be examined.

Report the probability of the accident occurring during the lifetime of the proposed action.

In determining which low frequency accident scenarios to analyze, document preparers should consider differences between natural phenomena and human-caused events with respect to the degree to which their consideration would inform decision making. It may not be useful to consider extremely low frequency accidents resulting from certain natural phenomena. For example, in many cases the acceleration forces associated with extremely rare earthquakes (e.g., frequencies of less than 10^{-6} per year) may be so great that destructive impacts unrelated to the proposed action or alternatives would overwhelm impacts associated with the proposed action or alternatives. Such an analysis would not be informative regarding the proposed action or alternatives because a decision maker would be unable to distinguish the consequences resulting from the proposed action or alternatives from the general destructive effects of the earthquake. Analyzing a higher frequency earthquake scenario, however, could be useful in making decisions about the proposed action and alternatives, such as whether a robust earthquake design or alternative location for a proposed facility is warranted.

[5] The probability of an event occurring during a project lifetime often can be approximated by multiplying the event frequency by the project duration. This approximation method is not mathematically accurate and provides acceptable estimates only for relatively short project durations and small frequencies, as in the example above. For events with greater frequencies or longer project durations, the probability of the event taking place during the project lifetime can be calculated using the formula: Probability = $1-(1-1/T)^N$, where N = the project’s lifetime in years, and T is the return period of the event in years. The annual probability of the event = 1/T. To illustrate, the probability that a 100-year storm event would occur in a given year is 0.01 [1/100]. The probability that the 100-year storm would occur during a project lifetime of 100 years is not 1.0 [100 x 0.01], rather, the probability is about 0.63 [$1-(1-1/100)^{100}$].

4.0 Risk

Separately present estimated accident consequences and probabilities.

Presenting the risk of an accident calculated by multiplying the probability of occurrence times the consequence is not sufficient. As noted in *Recommendations*, presenting only the product of these two factors masks their individual magnitudes. Risk should augment and not substitute for the presentation of both the probability of occurrence and the consequence of the accident.

4.1 Application to Accidents Involving Potential Radiological Releases

For transportation accidents, in addition to a probabilistic risk analysis, consider using a separate analysis to present both the probability and consequences of a maximum reasonably foreseeable accident.

Exposure of populations to low levels of ionizing radiation is associated with an estimated number of resulting latent cancer fatalities (LCFs) in the exposed population. If an accident involved radiation exposures, the potential LCFs would be a *consequence.*[6] The estimated number of LCFs (if the scenario were to occur) and the scenario probability should be presented in the NEPA review. This basic information may be supplemented with a risk estimate (i.e., number of LCFs multiplied by probability of the scenario).

Further, the *consequence* of a dose to an individual usually would be expressed as a *probability* that the individual would incur a fatal cancer. (This probability should not be confused with the probability that the accident scenario would occur both should be presented in the NEPA review.) For example, for an accident that would result in a 1-rem dose to the maximally exposed member of the public, a *consequence* of the accident would be about 1 chance in 1,700 (probability of 6×10^{-4}) that the maximally exposed member of the public would incur a fatal cancer as a result of the exposure.[7]

4.2 Application to Transportation Accidents

Consistent with the emphasis in this guidance on reporting accident consequences, document preparers should consider using two separate analytical approaches for accidents involving transportation of radioactive or hazardous materials. For example, DOE often uses a probabilistic risk assessment approach for transportation accidents involving radioactive materials by summing the products of the probabilities of occurrence of accidents over a range of severity classes and the consequences of the accidents in each severity class to yield total accident risk. Although such methods typically consider the full range of potential accident severity classes, including the most severe, these methods do not present consequences for a particular accident scenario that may be of interest, such as a maximum reasonably foreseeable accident.

[6] Note that the numerical expression of estimated LCFs itself is probabilistic in nature and should be interpreted in a statistical sense. Nevertheless, regard the estimated number of LCFs as a *consequence* of exposure to radiation.

[7] This calculation uses a dose-to-risk conversion factor of 6×10^{-4} LCF per person-rem of exposure.

Accordingly, consider analyzing the consequences of a maximum reasonably foreseeable transportation accident using a separate approach in which a specific type of location (e.g., an urban area or a rural area) and accident scenario is postulated (typically one with an estimated occurrence of 10^{-6} to 10^{-7} per year). This approach would enable the separate presentation of both accident consequences and probability for the maximum reasonably foreseeable accident, which is often of considerable interest to the public and local officials. *A Resource Handbook on DOE Transportation Risk Assessment* (DOE, 2002b) provides useful data for transportation accident analyses.

Be sure to consider non-radiological transportation accident risks, such as fatalities from collisions that do not result in any cargo releases. In many cases, such risks will be dominant.

5.0 Accident Consequences

5.1 Involved Workers

In the analysis of accidents, always consider potential impacts on involved workers. Fatal or serious non-fatal injuries may be expected because of a worker’s close proximity to the accident. In some cases, credibly estimating exposures for involved workers may require more details about an accident than could reasonably be projected or meaningfully modeled. As a substitute, the effects should be described semi-quantitatively or qualitatively, based on the likely number of people who would be involved and the general character of the accident scenario.

> **Example of a Qualitative Analysis Presentation**
>
> “Approximately 10 workers would normally be in the room where the accident could occur. While a few such workers might escape the room in time to avoid being seriously harmed, several would likely die within hours from exposure to toxic substances, and the exposed survivors might have permanent debilitating injuries, such as persistent shortness of breath.”

A more detailed, semi-quantitative discussion may be appropriate for analyzing proposals with substantially greater chemical or radiological risks. Attachment 2 illustrates the application of the sliding scale principle to determining the level of detail for such analyses. It is not intended to convey all of the factors that should be considered.

5.2 Noninvolved Workers

In the analysis of accidents, always consider potential impacts on noninvolved workers.

Noninvolved workers are workers who would be on the site of the proposed action, but not involved in the action. In principle, this population consists of all workers on a DOE site that are not involved workers. In practice, to ensure that the analysis is meaningful, document preparers should define this population and its maximally exposed member(s) in light of the specific facts and circumstances of each proposal. Attachment 2 regarding application of sliding scale principles also applies to noninvolved workers.

Always consider impacts on involved and noninvolved workers.

Define the noninvolved worker population and its maximally exposed member(s) for each alternative.

In many cases, a simple population impact estimate using an air dispersion model that considers the expected population between a location near the point of release (typically about 100 meters from the release point, depending on the circumstances) and the site boundary will be sufficient. In some cases, however, sub-populations of workers at the site may warrant specific consideration. Following are examples of sub-populations:

- Other workers in the same building or facility, or its immediate environs, in which an action is proposed

- Workers in buildings or locations immediately adjacent to the proposed project location (Where members of the public typically would be present in areas adjacent to noninvolved workers, such as child care centers, cafeterias or visitor centers, discuss whether accident impacts on such members of the public would be comparable to those estimated for noninvolved workers.)

- For large DOE sites with multiple facilities or geographically separate operational areas, the workers in specific downwind facilities or operational areas

- Specific classes or categories of workers that may be of special interest (See, for example, *Protection of Collocated Workers at the Department of Energy's Defense Nuclear Facilities and Sites* (DNFSB, 1999), which defines classes of populations applicable to hazardous nuclear facilities, including "collocated workers," "immediate workers," "other on-site worker personnel," "transient on-site personnel," and "off-site personnel.")

This guidance does not intend that analysis of impacts on all of these sub-populations is required, or that explicit analysis of any of the sub-populations is usually warranted in accident analyses under NEPA. Consider case-by-case, in accordance with the sliding scale principle, whether potential impacts on specific sub-populations of workers at the site and their maximally exposed members should be analyzed in light of the degree to which they may be harmed.

5.3 Accidental Contamination and Other Indirect Impacts

In evaluating the effects of an accident, characterize the degree to which buildings, land, and environmental media would be contaminated, and describe (at least qualitatively) the potential health and environmental effects from such contamination, including direct and indirect effects associated with potential cleanup activities. To the extent that such effects are not remote and speculative, and as appropriate in accordance with a sliding scale approach, consider the potential for other indirect effects of accidents (e.g., lasting economic effects, such as potential impacts on a commercial fishery or the costs of cleanup).

5.4 Radiological Ecological Impacts

Potential impacts to biota should be evaluated, as appropriate, when analyzing radiological accident scenarios under NEPA.

An adequate analysis of potential impacts on people from accidents can serve as a relative basis for analyzing impacts on biota in many cases, particularly when analysis shows that people likely would not be harmed. Although recent reports suggest there may be exceptions, in general, radiological doses that are unlikely to affect humans (e.g., doses below human radiation protection limits) are not known to cause measurable adverse effects to populations of plants and animals. This assumption may require further consideration in cases where human access to a contaminated area is restricted but access by other biota is not, unique exposure pathways exist for plants and animals that do not affect exposure of humans, and other stresses on plants and animals are significant (IAEA, 1992; ORNL, 1995).

Analyze impacts to biota, as appropriate, when analyzing radiological accident scenarios under NEPA.

An analysis of impacts to people often can be the basis for conclusions regarding impacts to biota.

It is usually sufficient to consider accident impacts on plant and animal populations rather than on individuals.

Regarding the current state of the science on dose limits for protection of biota, the International Atomic Energy Agency (IAEA), Technical Report Series No. 332, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards, 199*2, states that “[a]cute doses of 0.1 Gy [10 rad] or less are very unlikely to produce persistent, measurable deleterious changes in populations or communities of terrestrial plants or animals.” For chronic exposures, the IAEA concludes that “[t]here is no convincing evidence from the scientific literature that chronic radiation dose rates below 1 mGy/d [0.1 rad/day] will harm animal or plant populations.” Additionally, for the aquatic environment, the National Council on Radiation Protection (NCRP) concluded that a chronic dose of less than 10 mGy/d [1 rad/day] to the maximally exposed individual in a population of aquatic organisms would ensure protection of the population (NCRP, 1991).The IAEA is continuing to review and discuss concepts for a radiological protection framework for the environment, to include appropriate effects levels and dose limits for biota (IAEA, 1999; IAEA, 2002).

In analyzing accidents under NEPA, it is sufficient to consider only effects on flora and fauna populations, rather than individual members of a species, except in rare cases where (1) endangered or threatened species may be affected, or (2) commercially or culturally-valued species may be affected.

If no ecological effects from exposure to ionizing radiation would be expected, make a negative declaration, accompanied by a brief explanation of the scientific methodology and sources (such as the 1992 IAEA report) relied upon in arriving at conclusions regarding impacts (40 CFR 1502.24).

Explain the nature and relevance of uncertainties in presenting the results of accident analyses.

Describe the effect of incomplete or unavailable information on the results of accident analyses.

The Office of Environmental Policy and Guidance, through the Department's Biota Dose Assessment Committee (BDAC), has developed a DOE Technical Standard, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (DOE, 2000). The methodology, which uses assumptions of equilibrium conditions, is not intended for short-term, acute exposures that might be experienced during an accident. However, the methodology can be used to provide an indication of long-term recovery or health of a population following an accident. A summary of DOE's existing and recommended dose limits for protection of biota, and their technical basis, is also provided. A copy of the document may be downloaded from the DOE Technical Standards Program Web Site at: http://tis.eh.doe.gov/techstds/tsdrafts/envr0011 and from the BDAC Web Site at: http://homer.ornl.gov/oepa/public/bdac.

5.5 Non-radiological Ecological Effects

Consider non-radiological chemical and physical effects on biota commensurate with significance.

In considering potential non-radiological effects on biota, take account of differences among receptors with respect to sensitivity to toxic chemicals and routes of exposure. Accidents that do not result in immediate harm to humans could substantially harm biota (e.g., liquid chemical spills that result in fish kills).

6.0 Uncertainty

Many factors may contribute to uncertainty in accident analyses under NEPA. For example, NEPA documents often are prepared at the conceptual design phase of proposed new facilities, when design details are not available, resulting in uncertainties regarding accident scenarios.

Provide references for key data and assumptions used in accident analyses.

Decision makers need to understand the nature and extent of uncertainty in choosing among alternatives and considering potential mitigation measures. In all cases, the NEPA document should explain the nature and relevance of the uncertainty. Where uncertainties preclude quantitative analysis, the unavailability of relevant information should be explicitly acknowledged. The NEPA document should describe the analysis that is used, and the effect the incomplete or unavailable information has on the ability to estimate the probabilities or consequences of reasonably foreseeable accidents (40 CFR 1502.22).

In circumstances where substantial uncertainty exists regarding the validity of estimates, a qualitative estimate may be used. Regardless of whether a qualitative or quantitative analysis is performed, references supporting scenario probabilities, release fractions, and other data and assumptions used in the accident analysis should be provided.

Avoid presenting estimates for uncertain parameters that are unjustifiably precise (such as two significant figures for probability estimates). NEPA documents often are prepared before the detailed designs that would be needed for more precise estimates are available. Further, as described in *Recommendations*, for events that have large consequences, use a range of probabilities rather than a single estimate if it is not possible to determine the probability with much certainty. For events whose consequences are relatively low and numerical probability estimates are unavailable or difficult to obtain, qualitative descriptions such as "very infrequent" or "highly unlikely" may be adequate if the basis for such conclusion is provided.

7.0 Information Sources

Existing documents supporting the integrated safety management system (ISMS) for a facility or operation are potentially valuable sources of information for accident analyses under NEPA. Using these documents may help streamline the NEPA process by avoiding the duplication of analysis, and foster consistency in the Department's analyses. Further, their use can help ensure that the NEPA document benefits from the rigor required by the ISMS process.

This guidance refers generally to safety documents as *authorization basis* documents to emphasize their purpose as part of the process for authorizing nuclear or non-nuclear operations. These documents can include safety analysis reports, safety assessment documents, and several other commonly used formats. For nuclear facilities, most, if not all, authorization basis documents will be part of the documented safety analysis (DSA), which documents the extent to which a nuclear facility can be operated safely with respect to workers, the public, and the environment, including a description of the conditions, safe boundaries, and hazard controls that provide the basis for ensuring safety (10 CFR 830.3). Authorization basis documents may also include documents prepared in support of the ISMS process for non-nuclear facilities and operations.

In many cases, existing authorization basis documents may be summarized and incorporated by reference in NEPA accident analyses.

Additional analyses may be required to consider beyond-design-basis accidents, worker impacts, or new hazards.

Make sure that assumptions in authorization basis documents are appropriate for the NEPA review.

Ensure that accident risk comparisons among alternatives are fair by using a consistent set of assumptions or clearly noting any differences.

NEPA document preparers will need to review authorization basis documents to determine whether the major assumptions and scenarios are valid and appropriate for use in NEPA accident analyses. In conducting such reviews, NEPA document preparers should understand the different purposes of authorization basis and NEPA documents. For example, one purpose of a DSA and its accompanying hazard controls is to provide reasonable assurance that a DOE nuclear facility can be operated safely by defining and controlling commitments for design, procurement, construction, and operation. To accomplish that purpose, the DSA and accompanying hazard controls require substantially greater details of design and specific operations than are usually available when NEPA documents are prepared. NEPA documents usually are prepared early in the life cycle of proposed facilities, when only conceptual design information is available, and usually would precede authorization basis documents.

Authorization basis documents may be relevant for NEPA documents in several circumstances. For example, a NEPA document may consider a proposal to conduct a certain activity at an existing facility for which an authorization basis document exists. The existing facility may or may not require substantial improvements to enable the new activity, and the authorization basis document may or may not have explicitly considered the proposed new activity (e.g., prior to a decision whether to proceed with the proposal, regular updates to a DSA may not incorporate the proposed action).

If the major assumptions in the authorization basis document would remain valid for the proposed new activity then the accident analysis for the NEPA document may require no more than that the authorization basis document be summarized and incorporated by reference (40 CFR 1502.21). Even if the NEPA document requires further information to supplement analysis in the authorization basis document (e.g., to consider reasonably foreseeable beyond design basis accidents,[8] impacts to workers, or specific analysis of a new hazard), using information from the authorization basis document could improve the efficiency of the NEPA document preparation process.

In the example above, the NEPA document would analyze reasonable alternatives to locating a proposed activity at an existing facility, such as the construction of a new facility. Detailed design information would not be available for the proposed new facility, however, and an accident analysis for the new facility would need to be based on conceptual design. This poses a concern that comparisons of the accident risks among the alternatives would not be fair. For example, documentation for the existing facility might justify use of assumptions or analyses that take credit for a substantially greater degree of containment of accidental releases than might be

[8] "Design basis accidents" are accidents that are postulated for the purpose of establishing functional requirements for safety class and safety significant structures, systems, components, and equipment. A "beyond design basis accident" is an accident of the same type as a design basis accident (e.g., fire, earthquake, spill, explosion, etc.), but defined by parameters that exceed in severity the parameters defined for the design basis accident (DOE 2002a). In safety analysis reports, DOE considers the likelihood and consequences of beyond design basis accidents to provide a complete and documented rationale for acceptance or rejection of the operation of a facility, and to estimate the residual risk associated with facility accidents. Not all authorization basis documents have analyzed beyond design basis accidents. (Under NEPA, reasonably foreseeable accidents may or may not include both "design basis" and "beyond design basis" accidents, as described in the authorization basis documents.

justified for a new facility. An accident analysis could be misleading if it presented greater accident risks for the new facility without explaining the different assumptions used.

To ensure that accident risk comparisons among alternatives are fair, preparers should note differences in the analytical approaches used in the information sources for accident analyses, such as differences in the degree of conservatism and analytical approach (e.g., some NEPA and authorization basis documents have used different assumptions for meteorological conditions, dose commitment and accumulation duration, and other parameters). Preparers should ensure that all of the analyses are based on a consistent set of assumptions, or that differences are clearly explained.

In reviewing authorization basis documents for potential use as information sources in NEPA documents, consider whether accidents beyond the facility's design basis should be included in the NEPA document. If so, and if the authorization basis document did not consider beyond design basis accidents, then additional analysis will be required for NEPA compliance.

Because NEPA documents for new facilities are often prepared during the conceptual planning phase of a proposed project (and before start of detailed title II design), authorization basis documentation is usually not available to support the NEPA review. In some cases draft or preliminary authorization basis documents are available and may be a valuable source of information. For example, a preliminary documented safety analysis (PDSA) is prepared at an early stage in a nuclear facility's life cycle, when approval is sought for design, procurement, and construction. PDSAs are developed based on preliminary information regarding design and operating procedures. Although their purpose (to demonstrate that safe operation is possible and that design and operational constraints have been considered) differs from the purpose of a NEPA document, it may be possible to integrate their preparation with the NEPA process. Integrating a NEPA accident analysis with the corresponding authorization basis document preparation process would be highly desirable, although it will not always be possible to do.

As with any non-classified reference used to support a NEPA review, if a draft or preliminary authorization basis document is referenced in a NEPA accident analysis, then the referenced document (or the relevant parts thereof) must be available to the public.

8.0 References

DNFSB 1999, Protection of Collocated Workers at the Department of Energy's Defense Nuclear Facilities and Sites, Report No. DNFSB/TECH-20, Defense Nuclear Facilities Safety Board, Washington, DC, February.

DOE 1993, Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements, Office of NEPA Oversight, U.S. Department of Energy, Washington, DC, May.

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IAEA 1992, Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards. Technical Report Series No. 332, International Atomic Energy Agency, Vienna, Austria.

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NRC 1983, Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants. Revision 1. Regulatory Guide 1.145. U.S. Nuclear Regulatory Commission, Washington, DC.

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ORNL 1995. Effects of Ionizing Radiation on Terrestrial Plants and Animals: A Workshop Report, Report No. ORNL/TM-13141, Barnthouse, L.W., Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Regulations:

40 CFR Parts 1500-1508, Council on Environmental Quality, Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act.

10 CFR Part 830, Department of Energy, Nuclear Safety Management.

Related Issue: Intentional Destructive Acts (i.e., Acts of Sabotage or Terrorism)

In identifying the reasonably foreseeable impacts of a proposed action and alternatives, past DOE NEPA documents have addressed potential environmental impacts that could result from intentional destructive acts. Analysis of such acts poses a challenge because the potential number of scenarios is limitless and the likelihood of attack is unknowable.

Intentional destructive acts are not accidents. Nevertheless, NEPA documents have stated that the physical effects of a destructive act – whether caused by a fire, explosion, missile or other impact force – may be compared with the effects of accidents. That is, the consequences of an act of sabotage or terrorism could be discussed by a comparison to the consequences of a severe accident because the forces that could result in a release of radioactive or hazardous material would be similar to those considered in accident analyses. In some cases where the Department has considered destructive acts in a NEPA document, including facility and transportation scenarios, the consequences of destructive acts were "bounded" by those of severe accidents analyzed in the document. In other cases, the consequences of the destructive act were greater than but similar to those of accidents analyzed in the document.

When intentional destructive acts are reasonably foreseeable, a qualitative or semi-quantitative discussion of the potential consequences of intentional destructive acts could be included in the accident analyses.

Following are two examples of qualitative discussions of intentional destructive acts that might be appropriate in an EIS. The first example discusses potential sabotage at a hypothetical proposed fixed facility at a DOE site. This discussion might be appropriate for a proposal at the low-to-middle range of the sliding scale. The second example integrates a discussion of sabotage into a summary of accident impacts for a hypothetical proposal involving the transportation of nuclear waste or spent nuclear fuel. This discussion might be appropriate for a proposal at the high-end of the sliding scale.

Example of a Qualitative Discussion of Potential Sabotage on a Proposed Fixed Facility ("low" to "middle" sliding scale proposal)

In the aftermath of the tragic events of September 11, 2001, DOE is continuing to consider measures to minimize the risk and consequences of a potential terrorist attack. The proposed facility would offer certain unique features from a safeguards perspective: a remote location, restricted access afforded by Federal land ownership, restricted airspace above the site, and access to a highly effective rapid-response security force.

DOE based its analysis of the proposed facility on conceptual design information. If DOE decides to construct and operate the facility, as part of its detailed design and planning processes, DOE would continue to identify safeguards, security measures, and design features that would further protect the facility from terrorist attack and other forms of sabotage. DOE believes that the safeguards applied to the proposed facility should involve a dynamic process of enhancement to meet threats, which could change over time. Potential additional measures that DOE could adopt include:

- Facilities with thicker reinforced walls and roofs designed to mitigate the potential consequences of the impact of airborne objects
- Underground or surface bermed structures to lessen the severity of damage from aircraft crashes
- Additional doors, airlocks, and other features to delay unauthorized intrusion
- Additional site perimeter barriers
- Active denial systems to disable any adversaries and prevent access to the facility.

Although it is not possible to predict if sabotage events would occur, and the nature of such events if they did occur, DOE examined several accident scenarios that approximate the types of consequences that could occur. These accidents and their consequences are discussed in Section X.Y.Z.

Example of a Summary Discussion of Transportation-Related Accidents and Sabotage ("High" Sliding Scale Proposal)

In the EIS analysis DOE considered potential accidents based on the 19 truck and 21 rail accident cases presented in NUREG-6672, *Reexamination of Spent Fuel Shipment Risk Estimates* (issued in March 2000). DOE estimated potential impacts of postulated releases from accidents in three population zones – urban, suburban, and rural – under a set of meteorological (weather) conditions that represent the national average meteorology. In estimating accident probabilities, DOE used state-specific accident data, the lengths of routes in the population zones in states through which the shipments would pass, and the number of shipments. DOE also considered the risk of accidents involving both releases of radioactive material and loss-of-shielding accidents.

DOE also estimated impacts from unlikely but severe accidents called *maximum reasonably foreseeable accidents* to provide perspective about the consequences for a population that might live nearby. In its analysis of maximum reasonably foreseeable accidents, DOE considered each of the accidents presented in NUREG-6672 for both truck and rail transportation. For each accident, the possible combinations of weather conditions, population zones, and transportation modes were considered. The accidents were then ranked according to those that would have a likelihood greater than one in 10 million per year (accidents that DOE regards as reasonably foreseeable) and that would have the greatest consequences.

Real life transportation accidents involve collisions of many kinds, such as with other vehicles and along-the-route obstacles, involvement in fires and explosions, inundation, and burial. These accidents are caused, in turn, by a variety of initiating events including human error, mechanical failure, and natural causes such as earthquakes. Accidents occur in many different kinds of places including mountain passes and urban areas, rural freeways in open landscapes, and rail switching yards.

Thus, there are as many different kinds of unique initiating events and accident conditions as there are accidents. Analyzing each accident that could occur would not be practical. However, it is practical to analyze a limited number of accidents, each of which represents a grouping of initiating events and conditions having similar characteristics and encompassing a reasonable range of accidents. For example, the EIS analyzes the impacts of a collection of collision accidents in which a cask would be exposed to impact velocities in the range of 60 to 90 miles (97 to 145 kilometers) per hour. The EIS also analyzes a maximum reasonably foreseeable accident in which a collision would not occur but where the temperature of a rail cask containing spent nuclear fuel would rise to between 1,400^{o}F and 1,800^{o}F (between 750^{o}C and 1,000^{o}C). The conditions of the maximum reasonably foreseeable accident analyzed in the EIS envelope conditions reported for the Baltimore Tunnel fire (a train derailment and fire that occurred in July 2001 in Baltimore, Maryland). Temperatures in that fire were reported to be as high as 1,500^{o}F (820^{o}C), and the fire was reported to have burned for up to five days.

The estimated consequences of the maximum reasonably foreseeable transportation accident (an accident with the highest consequence for human health that can be reasonably foreseen) would be higher for rail transportation (five LCFs) than for truck shipments (one LCF), principally because the amount of material in a rail shipment would be larger than that in a truck shipment.

DOE also evaluated the potential consequences of an accidental crash of a large jet aircraft into a truck cask or rail cask. The analysis determined that penetration of the cask would not occur; however, potential seal failure could result in releases of radiological materials. The consequences associated with this event would be less than one latent cancer fatality (LCF) in an urban population.

The proposed action includes physical safeguards aimed at protecting the public from harm that could result from sabotage. Such safeguards would minimize the possibility of sabotage and facilitate the recovery of spent nuclear fuel shipments that could come under control of unauthorized persons. Safety features of transportation casks that provide containment, shielding and thermal protection also provide protection against sabotage. The casks would be massive.

It is not possible to predict whether sabotage events would occur and, if they did, the nature of such events. Nevertheless, DOE examined various accidents, including an aircraft crash into a transportation cask. The consequences of both the maximum reasonably foreseeable accident and the aircraft crash are presented in Section X.X.X for both rail and truck transportation, and provide an approximation of the type of consequences that could occur from a sabotage event. In addition, DOE estimated the potential consequences of a saboteur using a device to attack a truck or rail cask. Using highly-conservative assumptions, this analysis indicates that such an event could result in approximately 50 latent cancer fatalities in an assumed population of a large urban area.

DOE continues to examine the protections built into its physical security and safeguards systems for transportation shipments. DOE would modify its methods and systems as appropriate based on the results of this examination.

Attachment 2

Illustration:

Application of Sliding Scale Concepts to the Analysis of Potential Impacts on Workers from a Chemical Release Accident

← Level of Analysis →

Qualitative	Semi-Quantitative	Quantitative
Narrative discussion of potential consequences Estimated number of workers at risk Summary of potential acute and chronic consequences Detailed discussion of engineering controls or other potential mitigation measures usually unwarranted	Gross estimates of chemical concentrations at receptor location(s) Comparison of chemical concentrations to appropriate health-related references, such as: Emergency Response Planning Guidelines (ERPGs) Temporary Emergency Exposure Limits (TEELs) Reference Concentrations (R_fCs) Simplistic exposure assumptions (e.g., assume 15-minute time-weighted average for events with long release periods unless there are counter indications, such as substances that cause immediate adverse effects)	In addition to semi-quantitative considerations: Explicit consideration of mitigation measures, such as engineering controls, inventory reduction, and design changes Detailed dispersion modeling (e.g., time profile and frequency distribution of releases and concentrations at receptor locations) Potential for physical or chemical form changes (e.g., phosgene formation from carbon tetrachloride combustion; liquid-to-vapor changes) Detailed health effects analysis (e.g., potential impairment effects, dose-dependent effects, combined effects)

Low Risk ← Sliding Scale → Greater Risk

Attachment 3

Reprinted from Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements, May 1993 (“Green Book”)

6.4 ACCIDENT ANALYSIS

Background

This section deals with environmental impacts that will not necessarily occur under a proposed action, but which are reasonably foreseeable. The term "reasonably foreseeable" has no precise definition. Its interpretation should be guided by two primary purposes of NEPA review: (1) to determine whether a proposed action has the potential for significant impacts (EA), and (2) to inform an agency (and the public) in making reasonable choices among alternatives (EA and EIS).

For both purposes above, "reasonably foreseeable" includes impacts that may have very large or catastrophic consequences, even if their probability of occurrence is low, provided that the impact analysis is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason. Note, however, that a high-consequence event would not necessarily have "significant impacts" (in the sense of NEPA) if its probability of occurrence is very low. (The probability referred to in these discussions is the probability of the consequences of the accident or failure scenario occurring, not the probability of the initiating event occurring.)

EAs normally deal with proposed actions and analyzed alternatives that would not have potential for significant adverse impacts even under accident conditions. In contrast, EISs normally deal with larger scale projects that may have such potential. As with the choice of alternatives and the analysis of environmental impacts, use a sliding scale approach in considering impacts from potential accidents (or abnormal events). The nature of the proposed action or analyzed alternatives determines what types of potential accidents to consider, whether to describe impacts from accidents qualitatively or to analyze them quantitatively, and to what extent to consider very low probability events. Analyze impacts from reasonably foreseeable accidents to about the same extent as other impacts from the proposed action or analyzed alternatives, or even to a greater extent where impacts from accidents are the dominant concern.

Recommendations: Steps for determining which accident scenarios to analyze

- Identify the spectrum of potential accident scenarios (e.g., fire, impact or puncture events, HEPA filter failure) that could occur during construction, operations, and transportation activities encompassed by the proposed action and analyzed alternatives. Also identify failure scenarios from natural events (e.g., tornadoes, earthquakes) and human error (e.g., forklift accidents).

  For a proposed action that involves a facility or component with a set of design basis criteria (DOE 6430.1A[9]), consider the following two major categories of accidents.

Within design basis: First focus on accident, failure, or error scenarios within the design basis and determine the type of event that is likely to cause the greatest consequences, supporting that determination with rough estimates of or qualitative judgments about the magnitude of the consequences. Typically, these events will have probabilities of greater than 10^{-6} per year, especially for natural phenomenon events.

Beyond design basis: Look beyond design basis to see if there may be events of such large consequences that they need to be considered in order to satisfy the primary purposes of NEPA review as stated in the first paragraph in this section. Generally, examine the probability range 10^{-6} to 10^{-7} per year to the degree that events within this range bear on satisfying the two primary purposes of NEPA review cited above. As a practical matter (including litigation history), events with probabilities less than 10^{-7} per year will rarely need to be examined.

- Describe events that have very small consequences only qualitatively in the NEPA review, regardless of the probabilities.

- For events whose consequences are relatively low and numerical probability estimates are unavailable or difficult to obtain, qualitative descriptions such as "very infrequent" or "highly unlikely" may be used, provided that the basis for such a conclusion is described.

- Analyze events that have large consequences in terms of both their probabilities and consequences. If it is not possible to determine the probability with much certainty, use a range of probabilities.

- The term "consequence" refers to the results of an accident without consideration of the probability of the accident. Often, the product of probability and consequence, referred to as "risk," is provided as a measure of impact, but this product is not as informative as a presentation of its separate factors and is not the only definition of "risk."

Recommendations: Factors to consider in accident impact analysis

- Consider impacts on the public and on workers.

- Consider synergistic effects with nearby facilities, chemical as well as radiological.

- Consider common mode failures, including external initiators (such as earthquakes).

- Reference Safety Assessments and Safety Analysis Reports, if available.

[9] Since *Recommendations* was issued, DOE Order 6430.1A was replaced with two performance-based Orders: DOE O 420.1A, FACILITY SAFETY, and DOE O 430.1A, LIFE CYCLE ASSET MANAGEMENT. In addition, there are Guides and other documents developed for use with DOE O 420.1A and DOE O 430.1A which provide acceptable methodologies for satisfying requirements, including guidance on selecting industry codes and standards for aspects of design.