**Department of Energy**
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

MAY 7 1996

Mr. John T. Conway, Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W., Suite 700
Washington, D.C. 20004

Dear Mr. Conway:

RISK ACCEPTANCE CRITERIA

This letter supersedes my letter to you dated December 8, 1995, on this same subject. In the December 8 letter, I provided you the Risk Acceptance Criteria that the Assistant Manager for Tank Waste Remediation System (TWR) was implementing. During the DNFSB visit to Hanford in February of 1996, this topic was discussed, and the rationale for the planned TWR Risk Acceptance Criteria was presented. During the discussion, a concern was raised regarding Departmental policy for Risk Acceptance Criteria. Until issues regarding Departmental policy are resolved at Headquarters (HQ), EM has provided interim guidance to support ongoing safety analysis activities within TWR. Enclosure 1 provides this interim guidance. Enclosure 2 provides the WHC-CM-4-46, dated November 1989 referenced in Enclosure 1. The interim guidance presented in Enclosure 2 was previously used for the evaluation of the safety assessment associated with installation of the 101-SY Mixer Pump.

This guidance will be implemented for the TWR Basis for Interim Operation and the Final Safety Analysis Report (FSAR) and it is anticipated that this may cause a minor schedule delay. Additionally, the interim guidance is being studied for possible impacts to TWR facilities and operations as well as potential implications across the Hanford Site. This study will take approximately one month, and the conclusions will be provided to HQ as input to final policy development.

If you have any questions, please contact me or your staff may contact Paul Kruger, Director of the Office of Environment, Safety and Health, (509) 376-7387.

Sincerely,

John D. Wagoner
Manager

Enclosures:
1. Memo dtd 04/04/96
2. WHC-CM-4-46, dtd 11/89

cc w/encls:
R. Black, EH-31
R. Guimond, EM-2
M. Hunemuller, EM-38
J. Tseng, EM-4
M. Whitaker, S-3.1

United States Government Department of Energy

# memorandum

DATE: APR 04 1996

REPLY TO ATTN OF: EM-38

SUBJECT: Interim Radiological Dose Acceptance Criteria for the Hanford Tank Farms Safety Analysis

TO: Manager, DOE Richland Operations Office

The purpose of this memorandum is to provide risk evaluation criteria for use in preparing the Hanford Tank Farms Final Safety Analysis Report (FSAR).

As our staffs have discussed, there is need for prompt issuance of risk evaluation criteria for preparing the Hanford Tank Farms FSAR, scheduled for submittal to the Department of Energy (DOE) by September 30, 1996. The criteria can have a profound effect on the facility safety barriers and administrative controls and, therefore, on the cost and efficiency of operations at the facility.

We have reviewed various options in arriving at the criteria contained in this memorandum. They include:

- reliance on the existing Westinghouse Hanford Company (WHC) risk acceptance criteria,
- not using risk acceptance criteria; and
- reliance on previously-approved risk acceptance criteria as modified to reflect current concerns.

DOE does not currently have a Departmental policy or order which contains risk acceptance criteria. Our policy has been to rely on safety analyses, prepared in accordance with DOE-STD 3009, as well as compliance with orders governing operation and maintenance of our facilities, to determine that a facility was safe for operation. In some cases, such as the Hanford Plutonium Finishing Plant FSAR, and F-Canyon restart at Savannah River, contractor-issued risk acceptance guidelines were utilized as part of the safety analyses, and the safety documentation was used as a basis for DOE authorization to operate the facility.

To better enable consideration of onsite as well as offsite accident consequences, we are considering the preparation of DOE-wide risk acceptance guidelines. It is currently expected that these guidelines will cover radiological and non-radiological risk. However, they will not be available for several months and; therefore, will not support the preparation schedule for the Hanford Tank Farms FSAR. The guidelines contained in this memorandum should be considered as interim guidelines until the final guidelines are issued and the degree of application of those guidelines to existing analyses can be determined.

For preparation of the Hanford Tank Farms FSAR, the Richland Operations Office will use the risk evaluation guidelines approved for installation of the mixer pump in Tank 241-SY-101, as documented in Revision 0 of WHC-CM-4-46 (Nonreactor Facility Safety Analysis Manual, November 1989). These guidelines include allowable onsite and offsite accident doses as a function of accident probability. They are more conservative than the guidelines contained in the latest revision of the WHC Risk Acceptance Guidelines (WHC-CM-4-46, revision 4). We believe that they provide a reasonable set of interim guidelines for use until the Department's guidelines can be issued.

It is important to recognize that these guidelines are not avaluation points. They do not provide justification for not examining further risk reduction and not putting into effect additional common sense controls. The assurance of adequate protection for the public, our workers, and the environment requires us to reduce our risks to as low as reasonably achievable (ALARA). This is a direct correlation to the as low as reasonably achievable concept in occupational exposures to radiation.

Similarly, principles of waste minimization need to be considered in our effort to remediate the Hanford site. We must address reducing the expense of cleanup in the unlikely event that an accident should occur. Therefore, we need to include in the tank farms FSAR, consideration of what facility safety barriers and requirements should be implemented to reasonably reduce the contamination.

Contamination of a large area could have very serious effects on other site activities, Department operations elsewhere and, potentially, the public. We must carefully consider what actions we take to cost-effectively mitigate potentially severe accident consequences.

We will continue to coordinate with you in preparation of final risk acceptance guidelines. If you have questions on this matter, please do not hesitate to call me.

Richard J. Guimond
Assistant Surgeon General, USPHS
Principal Deputy Assistant Secretary
for Environmental Management

| | | |
|---|---|---|
| WESTINGHOUSE HANFORD COMPANY | Manual | WHC-CM-4-46 |
| | Section | 4.0, REV 1* |
| | Page | 1 of 15 |
| NONREACTOR FACILITY SAFETY ANALYSIS MANUAL | Effective Date | November 15, 1989 |
| | Organization | SQS/Safety |

TITLE:

RISK ASSESSMENT

Approved by

J. W. Hagan, Manager
Safety

## 1.0 PURPOSE

The purpose of this section is to define the methodology and procedures to be used when conducting risk assessment in support of a facility safety analysis and to define acceptable risk guidelines. Use of guidelines presented here will help ensure that evaluations of accident scenarios are based on approved standard criteria and that accident analyses demonstrate an operation can be conducted in a manner that adequately limits risks to the health and safety of the public and employees and the environment.

## 2.0 SCOPE

This section applies to all of the U.S. Department of Energy-Richland Operation Office (DOE-RL) nonreactor facilities and activities for which safety analysis reports (SARs) or safety analysis documents (SADs) are required and which are managed by Westinghouse Hanford Company (WHC).

## 3.0 RESPONSIBILITIES

### 3.1 LINE MANAGEMENT

It is the responsibility of line management, whether operating management or project management, to ensure that facility safety analyses are properly performed, documented, reviewed, and approved. Line management is also responsible for ensuring that facility or operational changes occurring subsequent to issuance of facility safety documentation are either covered by existing safety analysis documentation or are properly addressed in new documentation, with appropriate reviews and approvals. Line management is also responsible for ensuring that potential accident consequences are within the risk acceptance guidelines specified in this section. Where operating management and project management exist concurrently, operating management is responsible.

*This section has been completely rewritten; therefore, no change bars are used.

## 3.2 SAFETY

### 3.2.1 Independent Safety Review Organization

It is the responsibility of the Independent Safety Review Organization (ISRO) to review and approve all safety analysis documentation regarding the facilities under their cognizance.

### 3.2.2 Safety Support Services

Safety Support Services is responsible for maintaining and providing technical expertise in the area of safety analyses, radiological and toxicological release consequence analyses and criticality analyses, and Hanford Dose Overview Committee (HDOC) review of radiological release analyses.

Safety Support Services may be requested to perform safety analyses, radiological and toxicological release consequence analyses, and criticality analyses.

## 4.0 REQUIREMENTS

The U.S. Department of Energy (DOE) Orders and WHC management policies are based on a philosophy in which operations are conducted such that no undue risk could affect the health and/or safety of employees, visitors, members of the general public, or the environment. In order to implement this policy, it is appropriate to define acceptable risk guidelines and to compare risks of potential accidents with these guidelines.

The risk associated with the operation of any facility or activity will be reviewed and accepted on an individual, case-by-case basis. In general, however, facilities which are shown by appropriate analysis to be within the onsite and offsite risk acceptance guidelines shown in Tables 4-1 and 4-2 of this section are acceptable.

In all cases, actions shall be taken to minimize hazards and to ensure that all postulated consequences are within the criteria specified in this section. Hazards which are determined to present an unacceptable risk shall be eliminated.

## 5.0 PROCEDURE

For the purpose of SARs and SADs, facility or activity operating risk is defined as a function of the consequences of postulated accidents and the associated probabilities of occurrence for the accidents. The risk is thus determined by two processes. One process uses a variety of techniques to identify the potential credible accident event sequences which could occur at a facility or activity and estimates the likelihood of each sequence. Credible event sequences are those with annual probabilities higher than $10^{-6}$.

Event sequences identified by the analysis but with annual probabilities less than $10^{-6}$ are not evaluated for risk acceptance purposes. However, the sequences determined to be incredible shall be justified as such in the safety analysis. The second process uses various techniques to determine the consequences of each accident event sequence, in terms of potential impact to people and the environment. The result of this risk assessment is compared with the risk acceptance guidelines.

The radiological risk acceptance guidelines are shown in Table 4-1. The guidelines are to be applied as curves, as illustrated in Figure 4-1 of this section. The toxicological risk acceptance guidelines are shown in Table 4-2. As with the radiological guidelines, the toxicological guidelines are to be applied as curves, as illustrated in Figure 4-2 of this section. When practical, the results of the risk assessment should be reported as regions or error bars on graphs showing the associated risk acceptance guidelines, in addition to a tabular format. The size of the regions or error bars represents an estimate of the uncertainty associated with the analysis of the accident sequences. The overall process of risk assessment is illustrated in Figure 4-3 of this section.

It is intended that the depth and scope of the risk assessment be commensurate with the hazard classification of the facility or activity.

## 5.1 RISK ASSESSMENT

### 5.1.1 Event Sequence Identification

Event sequence identification is conducted in two phases. The first, called a preliminary hazards analysis (PHA), consists of an overall facility appraisal, using techniques appropriate to the nature of the facility or activity and processes being analyzed. The purpose of the PHA is to identify the broad range of potential event sequences [including, for preliminary safety analysis reports (PSARs), applicable construction related accident event sequences] and to assign a measure of perceived risk (see Tables 4-3 and 4-4) to each sequence. The outcome of the PHA is reported in a tabular format as shown in Figure 4-3. The last three entries in the PHA report format show, for each event sequence or category of event sequences, the barriers within the facility which prevent or mitigate the consequences of the accident, a rough estimate of the magnitude of consequences of the accident assuming that the listed preventive barriers fail, and the estimated likelihood of the event sequence occurring as stated.

In the second phase of the event sequence identification, a list of potential accidents which are determined to adequately represent the complete range of credible accidents (from anticipated to extremely unlikely) for the facility or activity is selected from the PHA. These sequences are then examined in greater detail, if necessary, to determine the probability of occurrence as accurately as possible, using fault-tree or event-tree analysis or similar techniques.

The particular techniques used to further evaluate potential event sequences are chosen in light of the potential consequences. For event sequences with potentially severe consequences, more complex analyses are needed; whereas, for less severe potential consequences, simpler and quicker techniques are appropriate. In any case, however, the techniques used to identify and evaluate potential accident event sequences must be proven methods which are in widespread use throughout industry, such as those listed as references 9 and 10 in this section.

Techniques available for estimating the error associated with the event sequence probabilities and consequences range from detailed Monte Carlo type techniques for use with fault-tree analysis codes to simple engineering estimates.

### 5.1.2 Consequence Estimation

Once the appropriate event sequences have been identified, the potential consequences for each are calculated. The depth of analysis used to determine these consequences should be commensurate with the potential magnitude of the consequence. For each of the parameters used to estimate potential consequences, with the exception of meteorology as discussed below, the most likely or expected values should be used. The worst case or maximum values are taken into account when estimating the uncertainties in the results of the analysis. A discussion of the methods used to estimate the uncertainties must be included in the safety analysis.

Accident consequences shall be calculated by using meteorological parameters specified in DOE Order 6430.1A, Section 0200-1.1.

## 5.2 RISK ACCEPTANCE

The results of the risk assessment, including design basis natural forces events (natural forces events with intensities or loads beyond the design basis shall not be considered), are compared to the appropriate risk acceptance guidelines as shown in Figures 4-1 and 4-2. The circled regions in Figure 4-3 represent the uncertainty and the dots within the regions represent the expected probability and consequences of an accident. In some cases, particularly those in which the worst-case consequences are within the most restrictive guidelines, the results of the risk assessment may be compared to the appropriate risk acceptance guidelines in tabular format. If the regions are below the corresponding risk acceptance guideline, the risk presented by the facility will generally be considered acceptable. However, the risk associated with the operation of any facility will be formally accepted on an individual, case-by-case basis.

Facility upsets or "offnormal conditions" which are expected to occur more frequently than 1/year are not considered accidents in the context of risk acceptance. Instead, these conditions are included as part of the impacts from normal operations (discussed in appropriate sections of the SAR) and are subject to the corresponding limits.

### 5.2.1 Risk Guidelines

The radiological and toxicological risk acceptance guidelines are shown in Tables 4-1 and 4-2. These guidelines are to be applied as curves as shown in Figures 4-1 and 4-2. For example, an event with an annual probability of $9 \times 10^{-3}$ which produces a potential effective dose equivalent (EDE) of 1 rem to the maximum offsite individual is not acceptable because it falls above the guideline in Figure 4-1, even though it lies within the stated range in Table 4-1.

Although the risk acceptance guidelines do not strictly apply for facility occupants, the potential consequences to facility occupants must be assessed, in order to establish the need for safety class systems.

The radiological risk acceptance guidelines represent EDEs and corresponding organ dose equivalents from all pathways (inhalation, air submersion, ingestion, and direct exposure). The reporting of radiological doses in safety analyses should identify the contributions from each pathway, and consideration should be given to the fact that action could be taken to control doses from ground contamination, ingestion, and water immersion if necessary.

### 5.2.2 Basis for Risk Guidelines

The tables are based on the philosophy that higher probability events, because they theoretically could occur more often, should have more restrictive guidelines than lower probability events. They are also based on the philosophy that offsite guidelines should be more restrictive than onsite guidelines. Setting offsite guidelines lower than onsite guidelines is consistent with common practice within the nuclear industry (e.g., annual dose limits and radionuclide concentration guides).

**5.2.2.1 Specific Basis for Radiological Guidelines.** The 25 rem ceiling for offsite individuals is well established in the nuclear industry as a siting criterion (DOE Order 6430.1A, LA-10294-MS, and 10 CFR 100) and is also suggested in LA-10294-MS as an offsite risk acceptance criterion for low probability events.

Westinghouse Hanford Company has applied the 25 rem as a risk acceptance guideline for both onsite and offsite consequences. It is recognized that consequences of any given accident may be higher onsite than offsite. However, since protective measures will be included in the evaluation of onsite consequences, the guideline of 25 rem is applied as an onsite guideline as well as an offsite guideline for events of low probability. The endpoint for both guidelines is thus established at the point corresponding to an annual probability of $10^{-6}$ and a dose consequence of 25 rem EDE or corresponding organ dose equivalents (i.e., 75 rem to the lens of the eye and 250 rem to all other organs, in accordance with DOE Order 5480.11, EDE, and organ dose equivalent limit relationships).

Draft DOE Order 5400.XX allows the public to be exposed to 0.5 rem/year EDE as a result of a planned noncontinuous exposure. Since the order states that a continuous exposure is one that is predicted to last longer than 5 years, it can be deduced that a noncontinuous exposure can last up to 5 years. It is therefore conservative to apply this criterion to events with an annual probability of $10^{-2}$, which is approximately equivalent to a frequency of one event (exposure) in 100 years. This provides a midpoint for the offsite guideline at an annual probability of $10^{-2}$ and 0.5 rem EDE or corresponding organ dose equivalents.

Draft DOE Order 5400.XX also specifies an annual limit of 0.1 rem EDE for continuous exposure of the public. It is conservative to set this as the limit for events with an annual probability approaching one, which provides an endpoint for the offsite guideline at an annual probability of one and 0.1 rem EDE or corresponding organ dose equivalents.

The DOE Order 5480.11 specifies an annual limit of 5 rem EDE for occupational exposure. It is therefore conservative to apply this criterion to events with an annual probability of $10^{-2}$. This provides a midpoint for the onsite guideline at an annual probability of $10^{-2}$ and 5 rem EDE or corresponding organ dose equivalents.

The DOE Order 5480.11 specifies a maximum allowable dose of 0.5 rem EDE to the unborn child of a worker. It is conservative to set this as the limit for events with an annual probability of one, which provides an endpoint for the onsite guideline at an annual probability of one and 0.5 rem EDE or corresponding organ dose equivalents.

All other dose guidelines are defined by lines on log-log graphs whose mid- points and endpoints are the onsite or offsite dose guidelines addressed above.

5.2.2.2 Specific Basis for Toxicological Guidelines and Explanation of Terms. A threshold limit value - time weighted average (TLV-TWA) is the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. It is considered conservative to use the TLV-TWA as an acceptable offsite guideline for higher probability accidents.

A threshold limit value - ceiling (TLV-C) is the concentration that should not be exceeded during any part of the working exposure. It is therefore appropriate to use the TLV-C as an acceptable onsite guideline for higher probability events. If a TLV-C is not provided for the material of concern, the threshold limit value - short-term exposure level (TLV-STEL) should be used in place of a TLV-C. If neither a TLV-C nor a TLV-STEL is provided for the material of concern, the TLV-TWA should be used as the endpoint in the risk acceptance curve for higher probability events.

The protective action guideline (PAG) is an airborne concentration below which it is believed that nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action. A concentration of 1 PAG at the site boundary will result in the declaration of a general emergency. Values for PAGs for several substances [1 PAG is equivalent to approximately 1/2 of an immediately dangerous to life and health (IDLH) concentration] can be found in WHC-CM-4-1, "Emergency Plan."

Since there are no irreversible or other serious health effects associated with exposure at PAG levels, it is considered conservative to use 2 PAGs (1 IDLH) as a guideline for onsite concentrations resulting from lower probability events and 1 PAG as a guideline for offsite concentrations resulting from lower probability events. If there is no PAG for the material of concern, Industrial Safety and Fire Protection or Safety Support Services should be contacted for assistance in developing an appropriate guideline.

When comparing calculated concentrations to a TLV-TWA, a TLV-STEL, or a PAG, the calculated concentrations should be normalized to an average concentration over a period of 8 hours, 15 minutes, and 1 hour, respectively. No normalization of calculated concentrations should be performed on those that will be compared to a TLV-C.

## 5.3 REVIEWS AND APPROVALS

Technical analyses and revisions and addenda to technical analyses included in safety analysis documents shall receive a one-over-one technical review by qualified personnel in the area of the assessment. Comments and resolutions resulting from these reviews shall be maintained in an auditable record.

## 6.0 REFERENCES

1. DOE Order 5400.XX, "Radiation Protection of the Public and the Environment (Draft)."

2. DOE Order 5480.11, "Radiation Protection for Occupational Workers."

3. DOE Order 6430.1A, "General Design Criteria."

4. Code of Federal Regulations, 10 CFR 100, "Reactor Site Criteria."

5. J.C. Elder, et al., "A Guide to Radiological Accident Considerations for Siting and Design of DOE Nonreactor Nuclear Facilities," LA-10294-MS, January 1986.

6. WHC-CM-4-1, "Emergency Plan."

## 7.0 BIBLIOGRAPHY

1. NUREG-1320, "Nuclear Fuel Cycle Facility Accident Analysis Handbook," USNRC, May 1988.

2. International Commission on Radiological Protection, "Recommendations of the International Commission on Radiological Protection," ICRP 26, Pergamon Press, Oxford, 1977.

3. International Commission on Radiological Protection, "Limits for Intakes of Radionuclides By Workers," ICRP 30, Pergamon Press, Oxford, 1979.

4. American Institute of Chemical Engineers, Battelle Columbus Division, "Guidelines for Hazard Evaluation Procedures," 1945.

Figure 4-1. Application of Radiological Risk Acceptance Guidelines for Effective Dose Equivalent

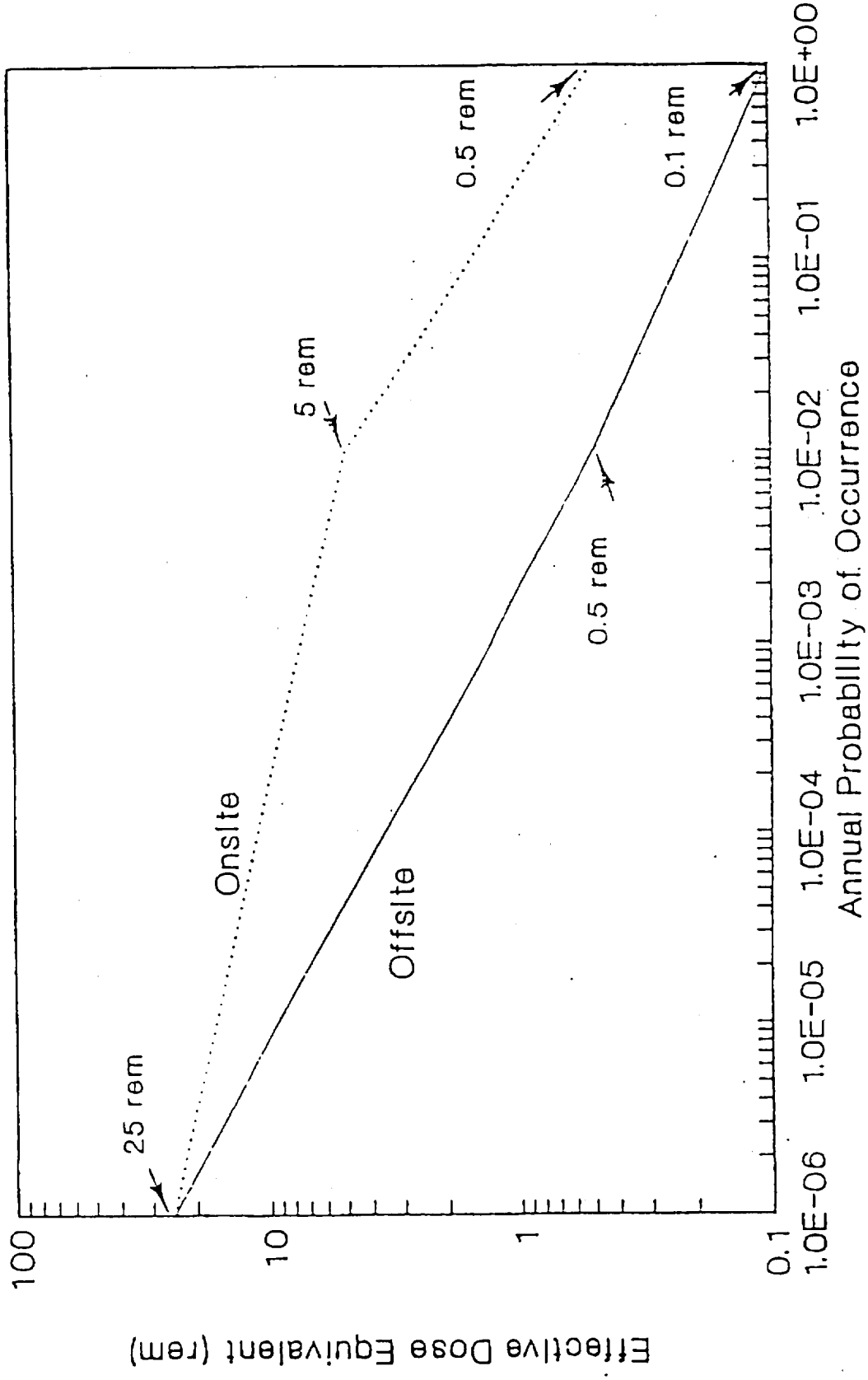

Figure 4-2. Application of Toxicological Risk Acceptance Guidelines for Chlorine

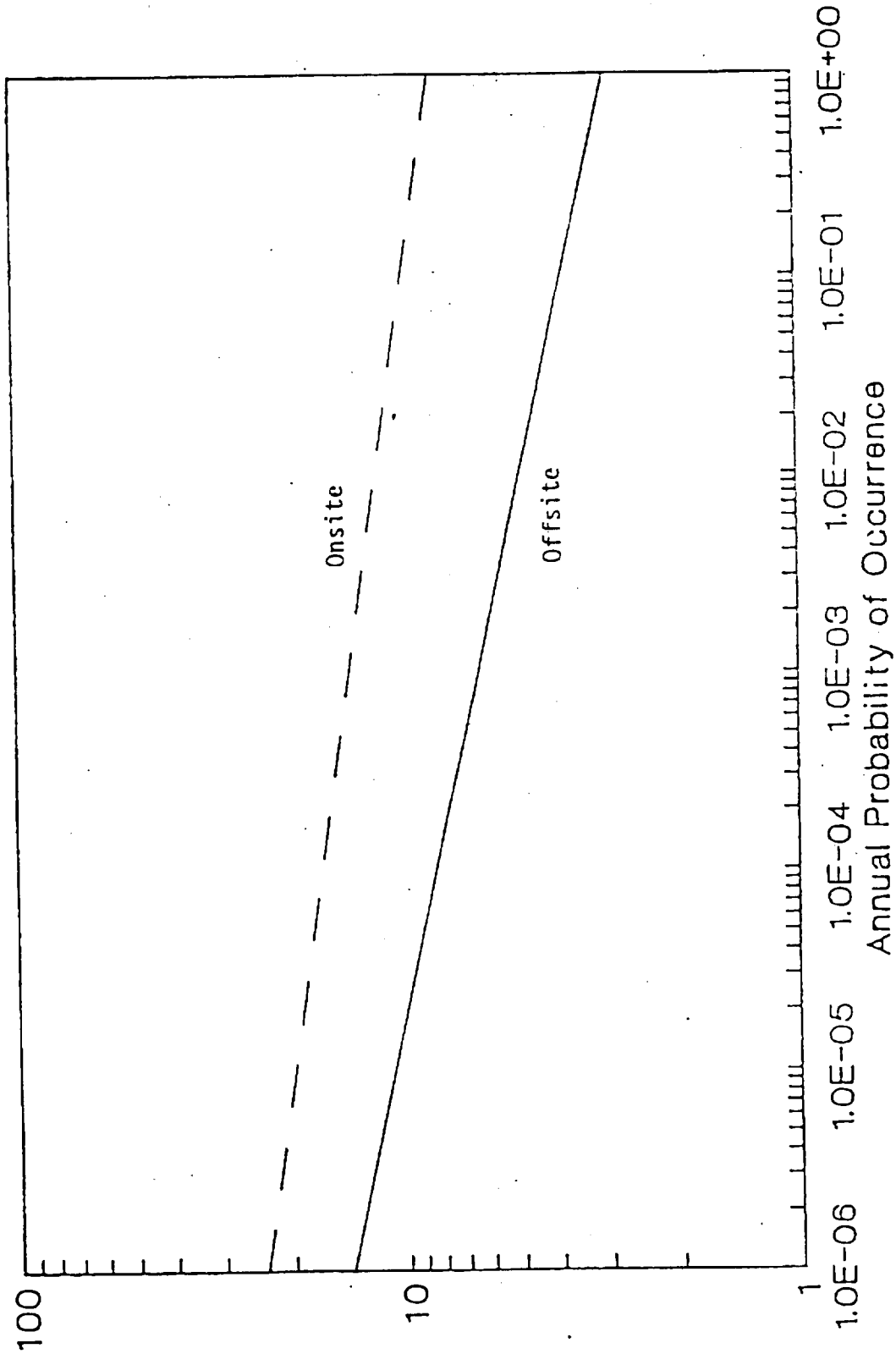

Figure 4-3. Risk Assessment Process

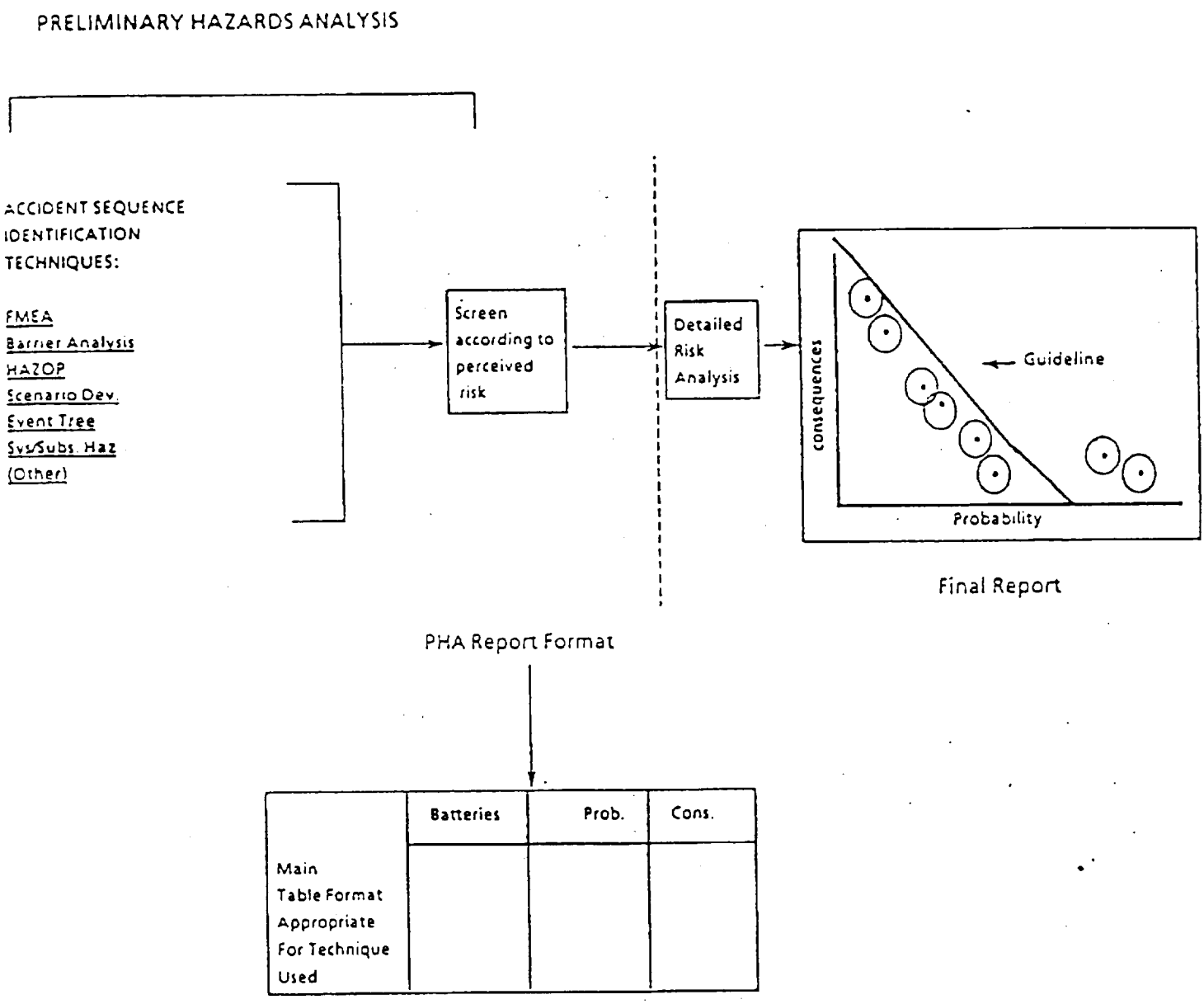

Table 4-1. Radiological Risk Acceptance Guidelines.*

| Probability Category** | Nominal Range of Annual Probability | Effective Dose Equivalent (rem) | Organ Dose Equivalent for Lens of Eye (rem) | Organ Dose Equivalent for All Other Organs (rem) |
|---|---|---|---|---|
| | | Offsite Guidelines | | |
| Anticipated | 1 to $10^{-2}$ | 0.1 - 0.5 | 0.3 - 1.5 | 1 - 5 |
| Unlikely | $10^{-2}$ to $10^{-4}$ | 0.5 - 4 | 1.5 - 12 | 5 - 40 |
| Extremely Unlikely | $10^{-4}$ to $10^{-6}$ | 4 - 25 | 12 - 75 | 40 - 250 |
| | | Onsite Guidelines | | |
| Anticipated | 1 to $10^{-2}$ | 0.5 - 5 | 1.5 - 15 | 5 - 50 |
| Unlikely | $10^{-2}$ to $10^{-4}$ | 5 - 10 | 15 - 30 | 50 - 100 |
| Extremely Unlikely | $10^{-4}$ to $10^{-6}$ | 10 - 25 | 30 - 75 | 100 - 250 |

* These guidelines are to be applied as curves as shown in Figure 4-1. The dose guidelines represent EDEs and organ dose equivalents from all pathways, and should be used for comparison only to doses calculated with a methodology consistent with that recommended by the International Commission on Radiological Protection (ICRP) in ICRP 26 and ICRP 30.

**See Table 4-3 for additional definitions of the probability categories used here.

Table 4-2. Toxicological Risk Acceptance Guidelines.*

| Nominal Range of Annual Probability | Concentration** | |
|---|---|---|
| | Onsite | Offsite |
| 1 to $10^{-6}$ | TLV-C to 2 PAG | TLV-TWA to PAG |

* These guidelines are to be applied as curves as shown in Figure 4-2.

**See paragraph 5.2.2(2) of this section and Appendix A of this manual for a detailed discussion of the acronyms used here.

Table 4-3. Probability Category Definition.

| Probability Category | Category Description | Nominal Range of Annual Probability |
|---|---|---|
| Anticipated | An offnormal condition that individually may be expected to occur once or more during plant lifetime. | $10^{-2}$ to 1 |
| Unlikely | Individually, the condition is not expected to occur during plant lifetime, but collectively, events in this category may occur several times. | $10^{-4}$ to $10^{-2}$ |
| Extremely Unlikely | Extremely low-probability conditions that are not expected during the plant lifetime but that represent extreme or limiting cases of faults identified as possible. This category includes design basis accidents. | $10^{-6}$ to $10^{-4}$ |
| Incredible | Accidents for which no credible scenario can be identified. | $<10^{-6}$ |

Table 4-4. Qualitative Accident Severity Levels.

| Severity Categories | Consequences to the Public, Workers, or Environment |
|---|---|
| Category I | May cause deaths onsite or loss of the facility/operation, major injuries or illness offsite, radiation exposure to offsite individuals in excess of annual limits, or severe impact on the environment. |
| Category II | May cause severe injuries or severe occupational illness onsite, exposure to onsite individuals in excess of annual limits, major damage to a facility/operation, minor illness or injury offsite, exposure to offsite individuals to radiation below annual limits, or major impact on the environment. |
| Category III | May cause minor injury or minor occupational illness onsite, or exposure of onsite individuals to radiation below annual limits, negligible impact offsite, or minor impact on the environment. |
| Category IV | Will not result in injury, occupational illness, or exposure onsite or offsite, or result in a significant impact on the environment. |