CHAPTER 4: OFFSITE CONSEQUENCE ANALYSIS

4.1 PURPOSE

The purpose of the CCCHSD Offsite Consequence Analysis (OCA) Guidance is threefold:

- The guidance is intended to supplement information resources that are already available in some form (e.g., *EPA's "General Guidance on Risk Management Programs*" and "*RMP Offsite Consequence Analysis Guidance*"). See the reference section in Exhibit 4.2 for additional resource information.

- The guidance is intended to provide specific recommendations for dispersion modeling parameter selection where guidance is not otherwise provided by EPA or OES.

- The guidance is also intended to reflect the information or communication needs of the local community, the emergency responders and/or administering agency, and the stationary source.

4.2 INTRODUCTION

The CalARP regulations require offsite consequence analyses for Worst-Case Scenarios (WCSs) and Alternative Release Scenarios (ARSs). These guidelines describe the requirements of EPA's Accidental Release Prevention Requirements and CalARP regulations, as well as CCCHSD expectations, with respect to OCAs. The EPA's Accidental Release Prevention Requirements (federal rule) and the CalARP regulations require you to perform a Worst-Case Scenario (WCS) and an Alternative Release Scenario (ARS) for regulated substances.

These guidelines focus on the technical aspects of scenario selection and reporting. They do not contain specific criteria for graphical reporting due to the variation in company resources, stationary source layouts, etc. You should work with CCCHSD representatives to provide consequence analysis results in a format appropriate for emergency response planning needs.

Following are descriptions of the WCS, ARS, and additional scenarios:

- A Worst-Case Scenario (WCS) analysis applicable to all stationary sources, regardless of the covered process program level, is as follows:

  - Program 1 processes (as discussed in Chapter 2 of this guidance document) must be shown to have no public receptors within the distance to the endpoint in the WCS. To demonstrate that a process is eligible for Program 1, you must carry out one worst-case analysis for <u>each</u> toxic substance and flammable substances as a class held above the threshold quantity in the Program 1 process. Only the worst-case release that results in the greatest distance to an endpoint must be reported. You must, however, maintain documentation of the worst case analyses, in accordance with Section 2775.1 of the CalARP regulations, for County review and program verification.

  - If your stationary source has Program 2 or Program 3 covered processes (processes that are not eligible for Program 1; see Chapter 2), you must provide information on <u>one</u> WCS representing all toxic regulated substances present above the threshold quantity, and <u>one</u> WCS representing all flammable regulated substances present above the threshold quantity. Only the worst-case release that results in the greatest distance to an endpoint must be reported. You must maintain documentation of the worst case analyses, in accordance with Section 2775.1 of the CalARP regulations, for County review and program verification.

- You are encouraged to use EPA-approved look-up tables to evaluate your WCSs to promote consistency across similar stationary sources. These include EPA's *RMP Offsite Consequence Analysis Guidance, May 24, 1996*, as well as model plans for certain industries, such as those listed in Chapter 6, which will be approved by EPA.

- You must submit an additional WCS if a WCS from another process at your stationary source would potentially affect different public receptors from those affected by the initial WCSs.

• An Alternative Release Scenario (ARS) analysis is applicable to all stationary sources with Program 2 and Program 3 covered processes. Note: No ARS analysis is required for regulated substances in Program 1 processes. If the worst-case analysis shows no public receptors within the distance to the endpoint, and the process meets other Program 1 criteria, you do not have to carry out an ARS analysis. In addition, no scenario analysis is required for any process that does not contain more than a threshold quantity of a regulated substance, even if you believe such a process is a likely source of release.

- An ARS represents a more likely release than the WCS, and may result in concentrations, overpressures, or radiant heat levels that reach the endpoints specified for these effects beyond the fenceline of your stationary source.

  Note: You may not have an ARS with a distance to an endpoint that goes beyond the fenceline. However, you still must report an ARS. You should explain in the RMP Executive Summary why the distance does not extend beyond the fenceline.

- At a minimum, you must present information on one ARS for <u>each</u> regulated toxic substance at your stationary source held above the threshold quantity in a process.

- At a minimum, you must present information on one ARS for each stationary source to represent all flammable substances that are held above the threshold quantity in a covered process.

  For example, if you have five regulated substances – chlorine, ammonia, hydrogen chloride, propane, and acetylene – above the threshold in Program 2 or 3 processes, you must analyze one ARS each for chlorine, ammonia, and hydrogen chloride (regulated toxic substances) and a single scenario to cover propane and acetylene (regulated flammable substances).

- You must consider your five-year accident history and failure scenarios identified in your hazard review or process hazards analysis in selecting ARSs for regulated toxic or flammable substances (e.g., you might choose an actual event from your accident history as the basis of your scenario). You also may consider any other reasonable scenarios.

- You should consider the needs of emergency response planners and the community when developing your ARS(s). The ARS for regulated substances should be the "worst credible release scenario"[1] modeled with conservative meteorological conditions that occasionally exist in the county. The hazard assessment results should represent a reasonable "outer bound" for use as your stationary source's emergency response planning scenario and for explaining the potential hazards of your operations to the community.

- You should consider developing and submitting additional scenarios that may provide useful emergency response or risk communication information (such as other meteorological conditions, mitigation effectiveness, past actual events, other receptors/locations etc.).

4.3 TOXIC AND REACTIVE SOLIDS

CalARP Table 3 includes toxic and reactive solids that are to be considered in both WCS and ARS analyses. In performing an OCA for toxic and reactive solids, you may use an EPA, California Air Resources Board, or OES approved model that appropriately considers the dispersion and settling of particles. For the WCS, you must assume a one-hour release duration, as well as the appropriate meteorological conditions. You should contact the County for more specific information and guidance on considerations for modeling toxic and reactive solids in WCS and ARS (where applicable). (Note: The final CalARP regulations regarding toxic solids were not final at the time this guidance document was published.)

4.4 CONDUCTING THE ANALYSIS

You may use EPA's *RMP Offsite Consequence Analysis Guidance* to carry out your consequence analysis, if you so choose. Results obtained using the methods in EPA's Guidance are expected to be conservative. Conservative assumptions have been introduced to compensate for high levels of uncertainty. EPA-approved model plans will also be available for certain industries, such as those listed in Chapter 6. These plans will contain look-up tables for use in completing your OCA. You must consult with CCCHSD prior to using these model plans in your OCA.

EPA's guidance is optional, and you are free to use other dispersion models, fire or explosion models, or computation methods provided that:

- They are publicly or commercially available or are proprietary models that you are willing to share with the implementing agency;
- They are recognized by industry as applicable;
- They are appropriate for the chemicals and conditions being modeled;
- You use the applicable definitions of Worst-Case Scenarios; and
- You use the applicable parameters specified in the rule.

Complex models that can account for many site-specific factors may give more accurate estimates of offsite consequences than the simplified methods in EPA's guidance, particularly for ARSs, for

1 The worst credible release scenario is the most serious (or significant) potential release(s) from your stationary source that is physically possible and reasonably feasible. If you performed an Off-Site Consequence Analysis as part of the RMPP for your stationary source, the worst credible release scenario should be sufficient for your ARS for toxic chemicals.

which EPA has not specified many assumptions. However, complex models may be expensive and do require considerable expertise to use; EPA's optional guidance is designed to be simple and straightforward. You will need to consider the tradeoff in deciding how to carry out your required consequence analyses. Exhibit 4-1 provides additional suggestions on making this decision. Exhibit 4-2 presents possible sources of assistance in modeling.

Whether you use EPA's guidance or another modeling method, remember that the results you obtain from modeling your WCS may differ greatly from the ARS. The WCS assumptions (i.e., source term conditions, meteorological conditions, etc.) are very conservative, and, regardless of the model used, you can expect very conservative results. Results from modeling the ARS will be less conservative than the WCS. These results will depend on many site-specific conditions (e.g., wind speed and other meteorological conditions) and factors related to the release (e.g., when and how the release occurs, how long it takes to stop it). You should make reasonable assumptions regarding such factors in developing your ARS. Different models likely will provide different results, even with the same assumptions.

EXHIBIT 4-1
CONSIDERATIONS FOR CHOOSING A MODELING METHOD

Approach	Examples	Advantages	Disadvantages
Simple guidance	EPA's *RMP Offsite Consequence Analysis Guidance*	• Free • No computer requirements • Simple to use • Provides all data needed • Provides tables of distances • Ensures compliance with rule	• Few site-specific factors considered • Little flexibility in scenario development
Simple computer models	EPA models	• No/low cost • May be simple to use • Can consider some site-specific factors	• Some may not be easy to use • May give conservative results • May not accept all of EPA's required assumptions • May not include chemical-specific data • May not address all consequences
Complex computer models	Commercially available models	• May address a variety of scenarios • May consider many site-specific factors	• May be costly • May require high level of expertise
Calculation methods	"Yellow Book" (Netherlands TNO)	• Low cost • No computer requirements	• May require expertise to apply methods • May require development of a variety of data

EXHIBIT 4-2
POSSIBLE SOURCES OF ASSISTANCE ON MODELING

- If you use certain models, users' groups may be a source of assistance; for example, there is an ALOHA model users' group.

- If you use a commercial model, you should be able to request assistance from the model developer or distributor.

- Publications of the Center for Chemical Process Safety of the American Institute of Chemical Engineers (AIChE) may provide useful information on modeling; examples of such publications include:

  – *Guidelines for Evaluating the Characteristics of Vapor Cloud Explosions, Flash Fires, and BLEVEs* (1994), and

  – *Guidelines for Use of Vapor Cloud Dispersion Models* (1987).

- EPA publications also may provide useful modeling information; examples include:

  – *Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants*, EPA-450/4-88-009 (September 1988), and

  – *Guidance on the Application of Refined Dispersion Models for Hazardous/Toxic Air Release*, EPA-454/R-93-002 (May 1993).

  – EPA guidance is available at http://www.epa.gov/scram001// (includes models for solids)

  – EPA's "*RMP Offsite Consequence Analysis Guidance,*" May 24, 1996 is available at http://www.epa.gov/swercepp/pubs/cons-ana.pdf

  – RMP*Comp, an electronic version of the EPA's OCA Guidance look-up tables, is available at http://www.response.restoration.noaa.gov/chemaids/rmp/rmp.html

4.5 WORST-CASE RELEASE SCENARIOS

EPA has defined a Worst-Case Scenario (WCS) as one that results in the greatest distance from the point of release to a specified endpoint. You must estimate the distance as follows:

- Appendix A of the CalARP regulations list the toxic endpoint you must use for federal regulated toxic substances. (Note: State-only regulated substances will be added to this table in 1998.) You should consult with CCCHSD regarding any substance that does not have a toxic endpoint. For the WCS for toxic substances, you must estimate the dispersion distance to the endpoint, using certain conservative assumptions concerning quantity released and release conditions.

- A vapor-cloud explosion is specified as the WCS for flammable substances. For the worst-case analysis for flammable substances, you need to estimate the distance to an overpressure endpoint of 1 pound per square inch (psi) resulting from a vapor-cloud explosion of a cloud containing the entire quantity of the regulated flammable substance.

This section describes the assumptions you must make and what you need to do to meet the requirements for WCS under the regulation. Exhibit 4-3 summarizes the required parameters for the WCS.

WORST-CASE RELEASES OF TOXIC SUBSTANCES

For the WCS for toxic substances, you need to use the assumptions discussed below, the properties of the substance, and an appropriate dispersion model or EPA's optional guidance to estimate the distance from the release point to the point at which the concentration of the substance in air is equal to the toxic endpoint specified in the rule. Because the assumptions required for the WCS are very conservative, the results likely will be very conservative. The endpoints specified for the regulated toxic substances are intended to be protective of the general public. For example, the ERPG-2 toxic endpoint is the maximum airborne concentrations below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects, or symptoms that could impair an individual's ability to take protective action.

In addition, the WCS is carried out using extremely conservative assumptions about meteorological and release conditions. The distance to the endpoint estimated under worst-case conditions should not be considered a zone in which the public would be in danger; instead, it is intended to provide an estimate of the maximum possible area that might be affected under extreme, unlikely, catastrophic conditions. It is the intention of CalARP regulations that the estimated distances provide a basis for a discussion among the regulated community, emergency responders, and the public, rather than a basis for any specific actions.

EXHIBIT 4-3
REQUIRED PARAMETERS FOR MODELING WORST-CASE SCENARIOS

ENDPOINTS
- Endpoints for toxic substances are specified in the rule (CalARP Appendix A to title 19).
- For flammable substances, the endpoint specified in the rule is overpressure of 1 pound per square inch (psi) for vapor cloud explosions.
- For those substances listed in table 3 of the CalARP regulations that do not have toxic endpoints, consult CCCHSD for further guidance.

WIND SPEED/STABILITY
- For toxic liquids and gases, use wind speed of 1.5 meters per second (3.4 miles per hour) and F stability class unless you can demonstrate that local meteorological data applicable to the site show a higher minimum wind speed or less stable atmosphere at all times during the previous three years.
- If you can demonstrate a higher minimum wind speed or less stable atmosphere over three years, these minimums may be used.

AMBIENT TEMPERATURE/HUMIDITY
- For toxic liquids and gases, use the highest daily maximum temperature and average humidity for the site during the past three years.

HEIGHT OF RELEASE
- For toxic liquids and gases, assume a ground level release.

TOPOGRAPHY
- Use urban or rural topography, as appropriate.

DENSE OR NEUTRALLY BUOYANT GASES
- Tables or models used for dispersion of regulated toxic substances must appropriately account for gas density.

TEMPERATURE OF RELEASED SUBSTANCE
- Consider liquids (other than gases liquefied by refrigeration) to be released at their highest daily maximum temperature, based on data for the previous three years, or at process temperature, whichever is higher.
- Assume gases liquefied by refrigeration at atmospheric pressure are released at their boiling points.

MODELING ASSUMPTIONS

Quantity CalARP has defined a WCS as the release of the largest quantity of a regulated substance from a vessel or process line failure that results in the greatest distance to a specified endpoint. For substances in vessels, you must assume release of the largest amount in a single vessel; for substances in pipes, you must assume release of the largest amount in a pipe. The largest quantity should be determined taking into account administrative controls. Administrative controls are written procedures that limit the quantity of a substance, either in a pipe or vessel. You must consider not only the amount stored in a process during normal operation, but also during special circumstances (e.g., during turnaround). Documentation must be made available to CCCHSD to justify and prove any administrative controls. You do not need to consider the possible causes of the WCS or the probability that such a release might occur; the release is simply assumed to take place.

Release Height All releases are assumed to take place at ground level for the WCS. This is a conservative assumption in most cases. Even if you think a ground-level release is unlikely at your stationary source, you must use this assumption for the worst-case analysis.

Wind Speed and Atmospheric Stability Meteorological conditions for the WCS are defined in the rule as atmospheric stability class F (stable atmosphere) and wind speed of 1.5 meters per second (3.4 miles per hour). If, however, you can demonstrate that the minimum wind speed at your stationary source (measured at 10 meters) is always higher than 1.5 meters per second, or that the atmosphere is always less stable than class F, you may use the minimum wind speed and most stable atmospheric conditions at your stationary source for the worst-case analysis. To demonstrate higher minimum wind speeds or less stable atmospheric conditions, you will need to document local meteorological data from the previous three years that are applicable to your stationary source. If you do not keep weather data for your stationary source, you may call another nearby source, such as an airport, or a compiler, such as the National Weather Service, to determine wind speeds for your area. Your airport or other source will be able to give you information on cloud cover. A small difference in wind speed probably will not lead to a significant decrease in the distance to the endpoint.

Temperature and Humidity For the WCS of a regulated toxic substance, you must assume the highest daily maximum temperature that occurred in the previous three years (the highest temperature reached in the last three years) and the average humidity for your stationary source. Information on temperature and humidity can be obtained at your stationary source or from a local meteorological station. EPA's *Offsite Consequence Analysis Guidance* assumes a temperature of 25^{o} C (77^{o} F) and 50 percent humidity. If you use the EPA's guidance for your offsite consequence analysis, you may use these assumptions even if the actual maximum average daily temperature at your stationary source is higher or lower. If the temperature at your stationary source is significantly lower, EPA's guidance may give overly conservative results, particularly for toxic liquids. Small differences in temperature and humidity are unlikely to have a major effect on results, however.

Topography Two choices are provided for topography for the WCS. If your stationary source is located in an area with few buildings or other obstructions, you should assume open (rural) conditions. If your stationary source is in an urban location, or is in an area with many obstructions, you should assume urban conditions.

Gas or Vapor Density For the WCS, you must use a model appropriate for the density of the released gas or vapor. Generally, for a substance that is lighter than air or has a density similar to that of air, you would use a model for neutrally buoyant vapors. The initial vapor density of a substance with respect to air can be estimated from its molecular weight, assuming air has a "molecular weight" of approximately 29. For a substance that is heavier than air (molecular weight greater than 29), you generally would use a dense gas model. There are cases where a dense gas model may be appropriate for a substance with molecular weight of 29 or less (e.g., release of a compressed gas as a cold vapor) or where a neutrally buoyant plume model may be appropriate for a substance with a higher molecular weight (e.g., release by slow evaporation, with considerable mixing with air). In addition, dense gases and vapors will become neutrally buoyant through mixing with air as they move downwind. If you can account for such conditions in modeling, you may do so. However, you will be in compliance with the RMP requirements if you use a model that considers only the initial density of the modeled substance with respect to air.

ESTIMATING RELEASE RATES

Toxic Gases Toxic gases include all regulated toxic substances that are gases at ambient temperature (temperature 25^{o} C, 77^{o} F). For the consequence analysis, the total quantity is assumed to be released as a gas over a period of 10 minutes, except in the case of gases liquefied by refrigeration under atmospheric pressure. The release rate (per minute) for a gas (not liquefied by refrigeration) is the total quantity released divided by 10. Passive mitigation measures (e.g., enclosure) may be taken into account in the analysis of the Worst-Case Scenario. A 10-minute release must be assumed for gases regardless of the model you use.

Gases liquefied by refrigeration alone (not under pressure) and released into diked areas may be modeled as liquids at their boiling points, if the pool formed by the released liquid would be greater than one centimeter (0.39 inches) in depth. In this case, you may assume the liquefied gas is released from a pool by evaporation at the boiling point of the gas. If the refrigerated liquefied gas is not contained by passive mitigation, or if the pool formed would have a depth of one centimeter or less, you must treat the released substance as a gas released over 10 minutes. EPA's analysis indicated that pools of gas liquefied by refrigeration with a depth of one centimeter or less would evaporate so rapidly at their boiling points that treatment as gaseous releases over 10 minutes is reasonable.

Toxic Liquids For toxic liquids, you must assume that the total quantity in a vessel is spilled, forming a pool. For toxic liquids carried in pipelines, you assume that the largest quantity that might be released from the pipeline forms a pool. Passive mitigation systems (e.g., dikes) may be taken into account in consequence analysis. You assume that the total quantity spilled spreads instantaneously to a depth of one centimeter (0.39 inches) in an undiked area or covers a diked area instantaneously. You estimate the release rate to air as the rate of evaporation from the pool. To estimate the evaporation rate, you need to estimate the surface area of the pool. You can take into account the surface characteristics of the area into which the liquid would be spilled; for example, some models for pool evaporation will take into account the type of soil, if the spill may take place in an unpaved area. Your modeling also should consider the length of time it will take for the pool to evaporate.

You may use any appropriate model to estimate the evaporation rate of a spilled regulated substance from a pool and estimate the dispersion distance to the specified endpoint of the regulated substance. The release rate can then be used to estimate the distance to the endpoint.

ESTIMATING DISTANCE TO THE ENDPOINT

You may use any appropriate model, as discussed above, to estimate the distance to the toxic endpoint specified in Appendix A of the CalARP rule for a release of a regulated toxic substance, using the required modeling assumptions.

WORST-CASE RELEASES OF FLAMMABLE SUBSTANCES

For the WCS involving a release of a regulated flammable substance (a flammable gas or volatile flammable liquid), you must assume that the total quantity of the flammable substance is released into a vapor cloud. A vapor cloud explosion is assumed to result from the release. If you use a

TNT-equivalent model, you must assume that 10 percent of the energy in the cloud contributes to the explosion. You must estimate the consequence distance to an overpressure level of 1 pound per square inch (psi) from the explosion of the vapor cloud.

As in the case of the WCS analysis for toxic substances, the worst-case distance to the endpoint for flammable substances is based on a number of very conservative assumptions. Release of the total quantity into a vapor cloud generally would be highly unlikely. Vapor cloud explosions are unlikely events; in an actual release, the flammable gas or vapor released to air might disperse without ignition, or it might burn instead of exploding, with more limited consequences. The endpoint of 1 psi is intended to be conservative and protective; it does not define a level at which severe injuries or death would be commonly expected.

To carry out the worst-case consequence analysis for flammable substances, you may use a TNT-equivalent model (i.e., a model that estimates the explosive effects of a flammable substance by comparison with the effects of an equivalent quantity of the high explosive trinitrotoluene (TNT), based on the available combustion energy in the vapor cloud). Such models allow you to estimate the distance to a specific overpressure level, based on empirical data from TNT explosions. If you use a TNT-equivalent model, you must assume that 10 percent of the flammable vapor in the cloud participates in the explosion (i.e., you assume a 10 percent yield factor for the explosion). You do not have to use a TNT-equivalent model; other models are available that take into account the characteristics of vapor cloud explosions.

NUMBER OF SCENARIOS

The number of WCSs you must analyze depends on whether you have processes that are eligible for Program 1 and whether you have both toxic and flammable regulated substances. You only need to consider the hazard (toxicity or flammability) for which a substance is regulated (i.e., even if a regulated toxic substance is also flammable, you only need to consider toxicity in your analysis; even if a regulated flammable substance is also toxic, you only need to consider flammability). The requirements for the number of WCS analyses you will need to carry out are discussed below.

PROGRAM 1 PROCESSES

To demonstrate that a process is eligible for Program 1 (see Chapter 2), you must show that the distance to the specified endpoint in a WCS analysis is smaller than the distance to any public receptor. The WCS analysis for each Program 1 process must be reported in the RMP. If you want to determine whether the processes at your stationary source may be eligible for Program 1, you may have to carry out a WCS analysis for each process. You will need to report the worst-case results for those processes you determine to be eligible for Program 1. If the distance to the endpoint in the worst-case analysis is equal to or greater than the distance to any public receptor, the process would be in Program 2 or Program 3 (discussed below). When you consider possible eligibility of your processes for Program 1, you may want to look particularly at processes containing flammable substances, which are likely to give shorter worst-case distances than toxic substances

PROGRAM 2 AND 3 PROCESSES

For all Program 2 and 3 processes together (see Chapter 2), you must carry out and report in the RMP one WCS analysis for regulated toxic substances and one worst-case analysis for regulated flammable substances. The reported scenario for toxic substances must be the scenario estimated to lead to the greatest distance to the specified toxic endpoint; for flammable substances, it must be the scenario estimated to lead to the greatest distance to 1 psi overpressure for a vapor cloud explosion. Additional WCS analyses must be reported for toxic or flammable substances if a WCS release from a covered process potentially would affect different public receptors from those affected by the scenario giving the greatest distance (e.g., because of the locations of the processes).

IDENTIFYING THE "WORST" WORST-CASE SCENARIO

Toxic Substances To determine the scenario that gives the greatest distance to the endpoint for processes containing toxic substances, you may have to analyze more than one scenario, because the distances depend on more than simply the quantity in a process. For toxic liquids, for example, distances depend on the magnitude of the toxic endpoint, the molecular weight and volatility of the substance, and the temperature of the substance in the process, as well as quantity. A smaller quantity of a substance at an elevated temperature may give a greater distance to the endpoint than a larger quantity of the same substance at ambient temperature. In some cases, it may be difficult to predict which substance and process will give the greatest worst-case distance. You also may need to carry out analyses of WCS for processes located at significant distances from each other to determine whether different public receptors might be affected by releases.

Flammable Substances For flammable substances, the greatest quantity in a process is likely to give the greatest distance to the endpoint, but there may be variations, depending on heat of combustion and distance to the fenceline. You may have to carry out several analyses to identify the scenario that gives the greatest distance to the endpoint. As in the case of toxic substances, you also may need to carry out analyses for processes located far apart from each other to determine whether different public receptors might be affected.

For both toxic and flammable substances, the worst-case distances should be considered only approximations; small differences in distances resulting from different scenarios may be ignored in selecting the "worst" worst-case scenario.

4.6 ALTERNATIVE RELEASE SCENARIOS

This section offers guidance on performing the ARS for your stationary source. Stationary sources must identify, select, and model/assess their ARSs in accordance with the requirements of Section 2750.4 of the CalARP regulations. EPA has defined an ARS as a scenario that is more likely to occur than the WCS and will reach an endpoint offsite, unless no such scenario exists.

Neither the federal rule nor the CalARP regulations specify the scenario to use (they provide a range of acceptable scenarios) or the meteorological conditions to use (they allow the typical meteorological conditions to be used) for the ARS. However, CCCHSD intends to use the ARS for emergency response planning and for addressing local community concerns. The ARS for regulated substances should therefore be the worst credible release scenario[2] modeled with conservative meteorological conditions that occasionally exist in the county. The hazard assessment results will then represent a reasonable "outer bound" for your stationary source's emergency response planning and for explaining the potential hazards of your operations to the community.

ARSs you submit to the EPA may be different than ARSs you submit to CCCHSD for emergency response planning. If this is the case, you may want to include your EPA ARS in your RMP to CCCHSD to communicate the range of different release scenarios to the community.

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2 The worst credible release scenario is the most serious (or significant) potential release(s) from your stationary source that is physically possible and reasonably feasible. If you performed an Off-Site Consequence Analysis as part of the RMPP for your stationary source, the worst credible release scenario should be sufficient for your ARS for toxic chemicals.

Following is a list of examples of the type of scenarios that should be considered for the ARS:

- Transfer hose release due to splits or sudden hose uncoupling;
- Process piping release from failures at flanges, joints, welds, valves and valve seals, and drains or bleeds;
- Process vessel or pump releases due to drain, bleed, or plug failure;
- Vessel or pipe rupture due to mechanical impact;
- Vessel overfilling and spill, or over pressurization and venting through relief valve or rupture disk;
- Shipping container mishandling and breakage or puncturing leading to a spill.

Additionally, other elements to consider in selecting the ARS are mitigation effectiveness and past actual events. For ARSs, you are permitted to take credit for any passive or active mitigation systems in place, provided they are capable of withstanding the event that triggered the release and would still be functional. If you take credit for any passive and/or active mitigation systems, you should be prepared to demonstrate that the system or equipment is reliable managed and maintained.

SCENARIO INFORMATION

ARS FOR RELEASES OF FLAMMABLE SUBSTANCES

Flammable material release scenarios can be broken down into two broad categories:

- Events where the offsite outcome is delayed, leaving some time for response (e.g., possible migration/dispersion of unignited vapor clouds and secondary events such as BLEVEs (boiling liquid, expanding vapor explosions) and subsequent ignition of liquid hydrocarbon spills), or

- Events where the offsite outcome is immediate (e.g., vapor-cloud explosions, which can occur within seconds or a few minutes following release).

You should consider the needs of public emergency response planners when selecting scenario(s) for inclusion in the Risk Management Plan (RMP). Offsite emergency responders are most interested in events where action can be taken to prevent public exposure (e.g., activation of the Community Warning System, shelter-in-place). As a result, you should report ARSs that have an offsite endpoint **and** when offsite emergency response can respond before ignition, if such a scenario exists.

You should consider including more than one ARS for flammable materials in the RMP. Unlike toxic materials, flammable material releases can result in varying offsite impacts, each with a range of severity. These can range from minor (visible fire and smoke) to major (potential burns or blast overpressure). If a single ARS for a flammable material release is being reported, the event meeting the preceding criteria that results in the greatest offsite impact is the most appropriate for emergency response planning.

Flammable material release scenarios for the RMP will be highly site-specific and include such factors as site layout, processing and storage conditions, and distance to public receptors. You should discuss selected flammable material release scenarios with CCCHSD to validate their usefulness for emergency response planning by the CCCHSD Incident Response (IR) Team. This is discussed in more detail in Chapter 8.

EPA has provided guidance on the selection of the ARS for flammable materials in "*General*

Guidance on Risk Management Programs."

TECHNICAL GUIDANCE FOR MODELING FLAMMABLE ALTERNATIVE RELEASE SCENARIOS

Methods used to determine the endpoint of flammable material releases vary depending on the scenario outcome to be modeled. Table 1 summarizes models commonly used for the various types of flammable event outcomes.

Table 1
Summary of Flammable Release Considerations

	Outcome	Modeling Endpoint	Primary Considerations	Available Modeling Methods[1]
Flash Fire[2]	Offsite Ignition	Lower Flammable Limit	A flash fire can result from migration of an unignited flammable vapor cloud. If the flammable portion of the cloud (between LFL and UFL) is ignited, a flash fire extending to the LFL can result.	EPA (Reference Tables 18-21) Refined Hazard Assessment/ Consequence Models
Pool Fire	Radiant Heat	5 kW/m^2	Burn rate is a function of pool surface area and heats of combustion and vaporization. Pool fires generally result from contained liquid spills that subsequently ignite. Radiant heat drops off rapidly with distance from the fire.	EPA (Equation 22) Refined Hazard Assessment/ Consequence Models
BLEVE[3]	Radiant Heat	Second-degree burn exposure	A BLEVE results when a pressure vessel containing a liquid above its normal boiling point catastrophically fails. BLEVEs may occur as a secondary effect of external fire that impinges on a storage vessel containing LPG.	EPA (Reference Table 22) CCPS (Chapters 6 and 9) Refined Hazard Assessment/ Consequence Models
Vapor Cloud Explosion	Overpressure	1.0 psi	Vapor cloud explosions can occur when a flammable vapor cloud that exists within a congested or contained volume is ignited. Only the mass of hydrocarbon within the confined volume is involved in the explosion. Unconfined hydrocarbon vapor burns as a flash fire.	EPA (Adjusted Reference Table 9, Adjusted Equation C-1) TNT Equivalency (CCPS, Chapters 4 and 7) Baker-Strehlow (CCPS, Chapter 4) Multienergy (CCPS, Chapters 4 and 7)

	Outcome	Modeling Endpoint	Primary Considerations	Available Modeling Methods(1)
Jet Fire	Radiant Heat	5 kW/m^2	Jet fires result when flammable materials contained under high pressure ignite following release. The main hazards from jet fires are radiant heat in the near field and possible secondary effects due to flame impingement on adjacent equipment. As with pool fires, the hazards drop off rapidly with distance.	No specific guidance in either the EPA or CCPS references. Refined Hazard Assessment/ Consequence Models API RP-521 Guidance on Radiant Heat from Flares.

(1) EPA methods are available in EPA's "Risk Management Program Offsite Consequence Analysis Guidance." CCPS methods are available in "Guidelines for Evaluating the Characteristics of Vapor Cloud Explosions, Flash Fires, and BLEVEs."

(2) The boundary of a flash fires resulting from a vapor cloud is determined by dispersion modeling to an endpoint equivalent to the lower flammable limit (LFL) of the released material. Refer to the Dispersion Modeling Parameter Table for more information on suggested modeling parameters.

(3) Boiling liquid, expanding vapor explosion.

ARS FOR RELEASES OF TOXIC SUBSTANCES

To estimate the distances to the toxic endpoint for ARSs, you must identify scenarios for the regulated substances in covered processes and model these scenarios using the appropriate methods

TECHNICAL GUIDANCE FOR MODELING TOXIC ALTERNATIVE RELEASE SCENARIOS

Following is a discussion on the modeling parameters to be used for modeling the ARSs.

TABLE 2
SUMMARY OF DISPERSION MODELING PARAMETERS FOR ARS

ISSUE	CCC RMP
Failure/Release Information	
Vessel/Pipe Release Rate	Evaluate on a scenario specific basis to be consistent with the physical conditions of scenario.
Vessel/Pipe Release Duration	Evaluate on a scenario specific basis to be consistent with the physical conditions of the scenario. Table 3 shows suggested values for consideration.
Temperature Of Released Material	Evaluate on a scenario specific basis to be consistent with physical conditions of scenario.
Storage/Process Pressure	Evaluate on a scenario specific basis to be consistent with physical conditions of scenario.
Initial Concentration Of Released Material (i.e., Pure Or Diluted)	Evaluate on a scenario specific basis to be consistent with physical condition of scenario.
Density Of Released Substances	Tables or models used for dispersion of regulated substances must appropriately account for gas density.
Release Height	Evaluate on a scenario specific basis.
Release Orientation (Vertical, Horizontal, Etc.)	Evaluate on a scenario specific basis.
Minimum Pool Thickness For Liquid Spills	Evaluate on a scenario specific basis to be consistent with physical condition of scenario.
Pool Area For Liquid Spills	Evaluate on a scenario specific basis to be consistent with physical condition of scenario.
Surface Type For Liquid Spills (Concrete, Soil, Gravel, Etc.)	Evaluate on a scenario specific basis to be consistent with physical conditions of scenario.
Mitigation System Information	
Passive Mitigation Systems Assumed To Function And Limit The Release Quantity	Passive mitigation may be accounted for only if (1) the initiating event for the release does not cause the system to fail, and the system will still function as intended, and (2) the system or equipment is reliably managed and maintained.
Active Mitigation Systems Assumed To Function And Limit The Release Quantity	Accounting for the benefits of active mitigation systems should be done on a case specific basis. Active mitigation should only be accounted for only if (1) the initiating event for the release does not cause the system to fail, (2) the system will still function as intended, and (3) the reliability of the system can be demonstrated by maintenance and/or testing.

Endpoint Information	
Toxic Endpoint	If you choose to use a dispersion model, the distance to the toxic endpoint concentration of released material should be plotted on a map of the area showing the plume oriented in the most frequent wind direction. A circle should be added to show the potential extent if the wind were from a different direction. The distance to the ERPG-3 concentration should be shown in addition to the distance to the ERPG-2 concentration (if available). Note: The ARS you submit to federal EPA must be based on the toxic endpoints provided in the regulation. Therefore, do not include the ERPG-3 results in your federal submission. If you choose to use the Look-up Tables, then the distance to the toxic endpoint concentration of released material should be plotted on a map of the area using an arrow to indicate the extent of the plume. A circle should be added to show the potential extent if the wind were from a different direction. The arrow should be oriented in the most frequent wind direction. Note: OES and OEHHA are developing toxic endpoints for all CalARP regulated substances.
Explosion Endpoint	1 psi
Thermal Radiation Endpoint	Use endpoint consistent w/ EPA WCS. Evaluate on a scenario-specific basis. The endpoint should be equivalent to 5 kW/m2 for 40-second exposure.
Receptor Height	Assume ground level as most hazard assessment models do not consider receptor elevation.
Model Averaging Time For Dispersion Calculations	For toxic releases, consider assuming an averaging time of 20 minutes or the duration of the release, whichever is less. Note: There may be situations where the use of the 20-minute averaging time may not reflect a reasonable safety factor. These scenarios should be discussed with CCCHSD to determine a more appropriate averaging time. The release duration, travel time, and averaging time associated with the endpoint should be considered as well. For all flammable releases, use an averaging time of one minute or less, unless you model an unignited vapor release. For unignited vapor releases, use the same criteria as a toxic gas release. The choice of an averaging time should reflect the scenario being modeled. For example, the averaging time for a short duration “puff” release (5 minutes or less) should be no longer than the release duration. A 5-minute release averaged over 60 minutes, for example, will reflect a lower toxic concentration predicted at public receptors. If dispersion models do not allow for averaging time adjustment, document the limitation, but **DO NOT** adjust toxic endpoint concentration.
Meteorological/Surface Information	
Wind Speed	You should use conservative (low) wind speed, such as 1.5 m/s

	(3.4 mph)
Stability Class	You should use 'F' or the most conservative for particular scenario and model used.
Ambient Temperature	Use conservative ambient temperature consistent w/ other meteorological conditions at your stationary source. Consider consultation with neighboring industrial stationary sources to ensure consistency.
Relative Humidity	Use typical relative humidity at your stationary source. Consider consultation with neighboring industrial stationary sources to ensure consistency.
Surface Roughness	Use surface roughness values from: - EPA RMP guidance, - CMA guidance document table, or - Evaluate on a stationary source specific basis.
Consequence Assessment Model /Method Information	
Type Of Model (Neutral Buoyancy Or Dense Gas)	Use EPA Look-up tables or models per EPA RMP Rule and guidance
Vapor Cloud Explosion Assumptions	Evaluate on a scenario specific basis, and use methods generally accepted as good engineering practice.

RELEASE DURATION

The following table shows minimum or "lower limit," generic isolation durations for releases that would normally be used for a well-engineered and well-run facility:

TABLE 3
GENERIC RELEASE DURATIONS[3]

Case	Duration until Isolation (minutes)	Notes
Automatic	1	This is only used where either the release is detected and a valve is closed automatically, with no human intervention, or where the device is "intrinsically automatic."
Rapid remote	<5	In this case, the valve has to be closed by an action at some remote and safe location. The release has to be rapidly detected, and communication and diagnosis have to be equally rapid.
Slow remote	<10	In this case, the valve has to be closed by an action at some remote location, but the system of detection, communication, and diagnosis is slower. This may be because it requires the initial detection to be verified by independent operation.
Manual	20+	In this case, isolation is only possible by manual intervention. This requires mobilization of the emergency team and attendance at the shutoff valve by at least two responders in full protective clothing and full breathing apparatus. The duration given is a minimum duration based on experience.
Repair	30+	In this case, no shutoff valve exists, and the leak has to be stemmed by

3 "Risk Management Strategies for Chlorine Installations", *Journal of Loss Prevention Process Industries*, 1994, Volume 7, Number 2, p.149.

		applying clamps, patches, etc. It requires the involvement of a full emergency team with back-up, and the availability of suitable equipment. It is normally used in the case of holes in vessels and tankers where no other means exists of stopping the flow from the hole. The duration given is very much a lower limit figure.

4.7 ESTIMATING AND REPORTING OFFSITE RECEPTORS

You must estimate residential populations within the circle defined by the endpoint for your WCSs and ARSs. In addition, you must report in the RMP whether certain types of public receptors and environmental receptors are within the circles.

To estimate residential populations, you must use the most recent Census data or any other source of data that you believe is more accurate. You are not required to update Census data or conduct any surveys to develop your estimates. Census data are available in public libraries and in the LandView system, which is available on CD-ROM (see box below). You must estimate populations to two-significant digits. For example, if there are 1,260 people within the circle, you may report 1,300 people. If the number of people is between 10 and 100, estimate to the nearest 10. If the number of people is less than 10, provide the actual number.

Census data are presented by Census tract. If your circle covers only a portion of the tract, you should develop an estimate for that portion. The easiest way to do this is to determine the population density per square mile (total population of the Census tract divided by the number of square miles in the tract) and apply that density figure to the number of square miles within your circle. Because there is likely to be considerable variation in actual densities within a Census tract, this number will be approximate. The rule, however, does not require you to correct the number.

How to obtain Census data and LandView

Census data can be found in publications of the Bureau of the Census, available in public libraries, including:
County and City Data Book
LandView can be ordered from the U.S. Bureau of the Census customer service at: (301) 457-4100; fax: (301) 457-3842. LandView is available on CD-ROM; a single disk is $95, the full 11-disk set is $795. LandView version 3 can also be downloaded from the Internet for free. Further information on LandView and other sources of Census data is available at the Bureau of the Census web site at www.census.gov. LandView is also available from the net, with one county of your choice, for free, from the address "www.census.gov/geo/www/tiger/ ".

You must note the presence of any schools, residences, hospitals, prisons, public recreational areas or arenas, or commercial or industrial areas within the circle, by checking off the appropriate boxes within the data element section of the RMP. You should specifically list schools, general acute care hospitals, long-term health care facilities, and child day care facilities within the vulnerability zone (a radius of one mile or the distance to the ARS toxic or flammable endpoint, whichever is greater) in the OCA section of the RMP. Most of these institutions or areas can be identified from local street maps. Recreational areas include public swimming pools, public parks, and other areas that are used for recreational activities (e.g., baseball fields). Commercial and industrial areas include shopping malls, strip malls, downtown business areas, industrial parks, etc.

Environmental receptors are defined as national or state parks, forests, or monuments; officially designated wildlife sanctuaries, preserves, or refuges; and Federal wilderness areas. All of these can be identified on local U.S. Geological Survey (USGS) maps (see below). You must note the presence of these specific types of areas that are within the circle by checking off the appropriate boxes within the data elements section of the RMP If any part of one of these receptors is within your circles, you must note that in the RMP, as well.

How to obtain USGS maps

(1) Contact USGS at: 1 (800) HELP MAP (toll-free)
(2) Request assistance in determining which 1:100,000-scale map(s) will contain your site and the area in the circle defined by the distance to the endpoint for the worst case. You may have to purchase more than one map if your site is located near the edge of one of the maps.
(3) Purchase the necessary map(s) for $4.00 per sheet from USGS or commercial dealers. More information is available at the USGS web site: www.usgs.gov. Order forms can be downloaded from the website and faxed to USGS at (302) 202-4693.

Note: The rule does not require you to assess the likelihood, type, or severity of potential impacts on either public or environmental receptors. Identifying them as within the circle simply indicates that they could be adversely affected by the release.

Mapping of WCS and ARS Results

You should submit graphical representation (or "maps") of the WCS and ARS results to CCCHSD. Graphical representations of the vulnerability zones on maps should include orientation of your stationary source to true north (i.e., with an arrow, latitude/longitude grid, etc.), along with either the plume (if using a dispersion model) or an arrow in the direction of the prevailing wind.

The size of the maps should be consistent for ease of use (i.e., one chemical release scenario per single page, size 8½" X 11" or 11" X 17"), and include a scale of the map (e.g., one inch equals 2,400 feet).