APPENDIX C

CONSEQUENCE ANALYSIS

CONSEQUENCE ANALYSIS
OF THE
PARAMOUNT REFINERY PROPOSED MODIFICATIONS

Prepared For

Environmental Audit, Inc.
1000-A Ortega Way
Placentia, California 92670-7125

Prepared By

Quest Consultants Inc.®
908 26th Avenue N.W.
Norman, Oklahoma 73069
Telephone: 405-329-7475
Fax: 405-329-7734

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QUEST

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SECTION 1
INTRODUCTION

Quest Consultants Inc. was retained by Environmental Audit, Inc. (EAI) to perform a credible worst-case consequence analysis for the Paramount refinery, located in Paramount, California. The objective of the study was to compare the extent of potential hazards associated with several proposed modifications to the hazards that currently exist in the refinery.

The study was divided into three tasks.

Task 1. Determine the maximum credible potential releases, and their consequences, for existing refinery units that are affected by modifications.

Task 2. Determine the maximum credible potential releases, and their consequences, for the proposed modified refinery units.

Task 3. Determine whether the consequences associated with the modifications produce potential hazards that exceed those that currently exist.

Potential hazards from the existing and proposed facilities are associated with accidental releases of toxic/flammable gas, toxic/flammable liquefied gas, and flammable liquids. Hazardous events associated with gas releases include toxic gas clouds, torch fires, and vapor cloud explosions. Hazardous events associated with potential releases of toxic/flammable liquefied gases include toxic clouds, torch fires, flash fires, and vapor cloud explosions. Releases of flammable liquids may result in pool fires, flash fires, or vapor cloud explosions.

The primary hazards of interest for releases from this refinery are flammable and toxic gas clouds. The potential hazard extents for torch fires, pool fires, and vapor cloud explosions are smaller than for flammable and toxic gas clouds. This study focuses solely on the extent of potential exposure to flammable and toxic gas clouds.

In addition to calculating the maximum extent of the potential hazards, the analysis was designed to produce a "before-and-after" modifications look at the refinery. A selected set of releases was evaluated to demonstrate the changes in hazard extent due to the proposed modifications. Calculations were performed for conditions that would produce the worst-case consequences.

SECTION 2
OVERVIEW OF THE PARAMOUNT REFINERY

2.1 Facility Location

Paramount's refinery is located in the southern portion of Los Angeles County, California, in a mixed use area. The surrounding land use includes some residential areas, commercial zones, and light industry.

2.2 Meteorological Data

Meteorological data for the Los Angeles area were reviewed to determine representative values for the temperature and relative humidity. The wind speed and stability class information was also reviewed to determine the range of conditions that are possible at the site. In this study, a low wind/stable condition (1.5 m/s wind, "F" stability) was evaluated for each dispersion calculation. These conditions often approximate the worst-case weather conditions for dispersion analysis. For the purposes of this analysis, the vapor cloud was assumed to travel in any direction with equal probability.

2.3 Description of Modifications to the Refinery

Quest has reviewed the proposed modifications for Paramount's refinery. In short, the main focus of the review was to identify whether there was an increase or decrease in the extent of potential hazards resulting from the addition of equipment or the alteration of the existing operating conditions. The refinery modifications can be grouped into seven categories that form the basis for comparison. The details of these changes are summarized below.

2.3.1 Comparison #1 - Addition of a Benzene Saturation and Isomerization Unit

In order to reduce the benzene content and increase the octane rating of light gasoline components, Paramount is proposing the addition of a combined Benzene Saturation and Isomerization Unit (BSIU). This unit concentrates the benzene by splitting the reformate stream into light and heavy reformate. The high benzene light reformate is then fed to a reactor that hydrogenates the benzene to convert it to cyclohexane. The hydrogenated light reformate then passes through isomerization reactors where low-octane straight chain paraffins are converted to higher octane branched paraffins. The resulting isomerate is then stabilized to control its vapor pressure. This results in a pentane stream that is piped to a storage vessel onsite. This new unit will be compared to an existing, similar process in the naphtha hydrotreater (HDS #1) which is located close to the proposed unit.

2.3.2 Comparison #2 - Replacement of the Light Naphtha Stabilizer Reboiler

The Light Naphtha Stabilizer currently uses a fired heat reboiler. In order to ensure a consistent distillation of the naphtha, Paramount has proposed to replace the fired reboiler with a steam reboiler. This will allow better control of the heat input and help to control the boiling range of the naphtha. This modification is not anticipated to cause any major change in the operational parameters of the Light Naphtha Stabilizer. Releases from the Stabilizer, before and after the modification, will be used for the comparison.

2.3.3 Comparison #3 - Modifications to the Naphtha HDS Stripper

In the current Naphtha Hydrodesulfurization (HDS) Stripper, contaminants are removed with hot hydrogen. This system does not reliably reduce sulfur, nitrogen, or water contamination to levels low enough for the reformer unit reactors. In order to provide a naphtha stream that will not poison the reaction catalysts, Paramount is proposing to convert the Hot Hydrogen Stripper with a reboiled stripper. This change necessitates the addition of a reflux accumulator vessel to the stripper. The stripper overhead conditions will also be changed slightly. The existing hazards associated with the HDS Stripper will be compared to hazards generated by the proposed equipment additions.

2.3.4 Comparison #4 - Addition of the Naphtha Splitter

To provide a benzene-concentrated naphtha stream to the new BSIU, a Naphtha Splitter column is proposed. This equipment (distillation column, overhead accumulator, reboiler, and associated equipment) will distill light straight-run naphtha into unstabilized light naphtha and heavy naphtha streams. Benzene is concentrated in the heavy naphtha stream for further processing in the BSIU. The unstabilized light naphtha is condensed in the overhead accumulator and sent to the existing Light Naphtha Stabilizer. The naphtha splitter will be located near the Naphtha Stabilizer. These two distillation columns (and their associated equipment) will form the basis of this before-and-after comparison.

2.3.5 Comparison #5 - Addition of Pentane Loading and Ethanol Unloading

One component of the reformulated gasoline that is to be produced by the proposed modifications is ethanol. The addition of ethanol to gasoline requires that ethanol unloading facilities be added to the Paramount refinery. Due to the addition of ethanol in gasoline blending, the pentane components of the naphtha blendstock must be removed (to achieve the proper control of the mixture vapor pressure). This will be accomplished in the BSIU, with the pentane stored on site in a pressurized vessel. Some of the pentane will be blended into gasolines, and the remainder shipped out of the refinery by truck. Loading into pressurized truck transports will also require a new loading rack. Paramount expects to ship out approximately 200 barrels per day, or one truckload of pentane per day. For comparative purposes, releases of pentane and ethanol will be evaluated, along with releases of butane and gasoline, which are currently loaded/unloaded at the facility.

2.3.6 Comparison #6 - Upgrade of Gasoline Blending Facilities

In order to provide the capabilities for blending various naphtha streams, ethanol, and pentane, as well as the other (unchanged) blending stocks, the gasoline blending facilities will be upgraded. Piping, pumps, control systems, and analyzers will be added to accommodate the changes. Modeling for this change involves the evaluation of naphtha, butane, and pentane releases in the blending area.

2.3.7 Comparison #7 - Addition of the PSA Unit

The three HDS units at the Paramount refinery require a steady supply of hydrogen in order to remove contaminants from the fuel blending stocks. The proposed addition of a Pressure-Swing Absorption (PSA) unit will provide a high-purity hydrogen stream for this purpose. The PSA hydrogen will replace the current hydrogen supply from the reformer unit. Thus, the comparison can be made between the gases handled by the proposed PSA unit and the existing gases produced by the reformer.

SECTION 3
POTENTIAL HAZARDS

3.1 Hazards Identification

The potential hazards associated with Paramount's existing and proposed refinery units are common to many petrochemical facilities worldwide, and are a function of the materials being processed, processing systems, procedures used for operating and maintaining the facility, and hazard detection and mitigation systems. The hazards that are likely to exist are identified by the physical and chemical properties of the materials being handled and the process conditions. The focus of this analysis was the evaluation of the toxic and/or flammable hazards associated with the processed materials.

3.2 Physiological Effects of Hydrogen Sulfide

The analysis performed on this refinery involved the evaluation of several potential releases containing hydrogen sulfide (H_2S). These potential releases may result in persons downwind of the release being exposed to H_2S gas. H_2S is a colorless gas, with a strong, irritating odor (often described as a "rotten egg" smell). H_2S has a low threshold limit value (TLV) and is detectable by odor at concentrations significantly lower than those necessary to cause physical harm or impairment. The most serious acute hazard presented by H_2S is exposure to a high enough H_2S gas concentration for a long enough period of time such that the exposed person's ability to escape the release is impaired.

For this study, the hazard level to be evaluated is defined as the ERPG-2 level. The ERPG-2 level for a toxic hazard is defined as a hazard level that would irritate, but not seriously injure, exposed members of the public following exposure for up to sixty minutes. The ERPG-2 level for H_2S is 30 ppm (see Table 3-1).

3.3 Physiological Effects of Flash Fires

A potential consequence associated with most of the releases from the Paramount refinery is exposure to the heat of a flash fire, which is the result of delayed ignition of a flammable vapor cloud following a release of a flammable fluid. The physiological effect of fire on humans depends on the rate at which heat is transferred from the fire to the person, and the time the person is exposed to the fire. Even short-term exposure to high heat flux levels may be fatal. This situation could occur when persons wearing ordinary clothes are inside a flammable vapor cloud (defined by the lower flammable limit) when it is ignited. Persons located outside a flammable cloud when it is ignited will be exposed to much lower heat flux levels. If the person is far enough from the edge of the flammable cloud, the heat flux will be incapable of causing injuries, regardless of exposure time.

The endpoint used in the dispersion modeling for flammable vapor clouds is the lower flammable limit (LFL). This is expressed as a concentration of the released material, in air, and defines the extent of the flammable hazard.

Table 3-1
Effects of Different Concentrations of Hydrogen Sulfide

Description	Concentration (ppmv)	Reference
ERPG-1. The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.	0.1	AIHA
TLV (Threshold Limit Value).	10	ACGIH
ERPG-2. The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.	30	AIHA
ERPG-3. The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.	100	AIHA
Minimum concentration for the onset of lethality after 30-minute exposure (fatal to 1% of exposed population).	256	CCPS
IDLH. This level represents a maximum concentration from which one could escape within 30 minutes without any escape impairing symptoms or any irreversible health effects.	300	NIOSH[1]
Minimum concentration for 50% lethality after 30-minute exposure (fatal to 50% of exposed population).	440	CCPS
Concentration of H_2S reported to have been fatal to humans after 30-minute inhalation exposure.	600	NIOSH[2]
Minimum concentration for 99% lethality after 30-minute exposure (fatal to 99% of exposed population).	756	CCPS
Concentration causing edema, strangulation, asphyxia. Fatal almost immediately.	1,000	Sax

ACGIH *TLV's - Threshold Limit Values and Biological Exposure Indices for 1986-1987*. American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1986.

AIHA, *Emergency Response Planning Guidelines*. American Industrial Hygiene Association, Akron, Ohio, 1988.

CCPS - *Chemical Process Quantitative Risk Analysis*. Center for Chemical Process Safety of the American Institute of Chemical Engineers, New York, New York, 1989: p. 156.

NIOSH[1] - *Pocket Guide to Chemical Hazards*. Publication No. 78-210, Superintendent of Documents, Washington, D.C.

NIOSH[2] - *Registry of Toxic Effects of Chemical Substances, 1981-1982*. National Institute for Occupational Safety and Health, 1983.

Sax - *Hazardous Chemicals Desk Reference*, N. I. Sax and R. J. Lewis, Sr. Van Nostrand Reinhold, New York, 1987.

3.4 Selection of Accidental Release Case Studies

3.4.1 Overview of Methodology

The purpose of the hazard case selection methodology is to define the maximum credible hazard scenario for each portion of the process that might result in an impact to the public. The methodology developed for this work consisted of the following steps:

- Initial review of available documentation
- Evaluation of process parameters and equipment arrangement
- Selection of potential hazard scenarios

3.4.2 Initial Review of Available Documentation

The analysis begins with a general review of the process or proposed process. Any written description of existing, new, or modified processes is studied to determine the physical and chemical transformations occurring and the general flow of material in the unit. Documentation, such as process flow diagrams (PFDs), heat and material balances, and piping and instrumentation diagrams (P&IDs), is also reviewed.

3.4.3 Evaluation of Process Parameters and Equipment Arrangement

Each section of the refinery that is subject to a proposed modification is analyzed to determine potential release locations. Process parameters, such as temperature, pressure, liquid inventory, line diameter, and H_2S content, are considered in the determination of the potential for affecting offsite populations with the hazards discussed earlier in this section. Other factors, such as fluid flow rate, process flow patterns, and process shutdown systems, are considered in the analysis. For this study, the focus was on identifying accident scenarios that had the potential to create the largest hazard, in both the existing and proposed systems.

3.4.4 Selection of Potential Hazard Scenarios

A set of potential accident scenarios for each refinery modification was selected in order to demonstrate the change in hazard due to the proposed modifications. Scenarios were primarily selected based on the process discussed in Sections 3.4.2 and 3.4.3. They were also selected to provide a comparative analysis between the existing and proposed process systems. For example, if the proposed modifications involved the addition of a distillation tower and overhead reflux accumulator, a potential accident scenario may involve a release from the accumulator. The corresponding accident in the existing process system would be chosen from an accumulator in a similar, adjacent portion of the refinery. Thus, similar accident locations with the largest hazard potential from each system were analyzed. Table 3-2 presents the 21 accident scenarios that were selected to perform a comparison of the seven modifications presented in Section 2 of this report.

3.5 Consequence Modeling

When performing site-specific consequence analysis studies, the ability to accurately model the release, dilution, and dispersion of gases and aerosols is important if an accurate assessment of potential exposure is to be attained. For this reason, Quest uses a modeling package, CANARY by Quest®, that contains a set of

Table 3-2
Potential Release Scenarios Evaluated for the Paramount Refinery Modifications

Comparison Number	Release From	Release Hole Size (in)	Old System	New System
1	Reformer Stabilizer Overhead Accumulator	6	x	x
	BSIU Reformate Splitter Accumulator	6		x
	BSIU Stabilizer Accumulator	4		x
2	Existing Light Naphtha Stabilizer	6	x	
	Modified Light Naphtha Stabilizer	6		x
3	Existing #1 HDS Stripper Overhead	4	x	
	Modified #1 HDS Stripper Overhead	4		x
	#1 HDS Stripper Reflux Accumulator	3		x
4	Light Naphtha Stabilizer Overhead Accumulator	6	x	x
	Naphtha Splitter Overhead Accumulator	6		x
5	Butane Loading Hose	2	x	x
	Gasoline Loading Hose	4	x	x
	Pentane Loading Hose	2		x
	Ethanol Unloading Hose	4		x
6	Light Naphtha at Gasoline Blending	4	x	x
	Butane at Gasoline Blending	3	x	x
	Pentane at Gasoline Blending	2		x
7	Reformer Stabilizer Offgas	2	x	x
	Reformer Produced Hydrogen	4	x	x
	PSA High Purity Hydrogen	6		x
	PSA Fuel Gas	3		x

complex models that calculate release conditions, initial dilution of the vapor (dependent upon the release characteristics), and the subsequent dispersion of the vapor introduced into the atmosphere. The models contain algorithms that account for thermodynamics, mixture behavior, transient release rates, gas cloud density relative to air, initial velocity of the released gas, and heat transfer effects from the surrounding atmosphere and the substrate. The release and dispersion models contained in the QuestFOCUS package (the predecessor to CANARY by Quest) were reviewed in a United States Environmental Protection Agency (EPA) sponsored study[1] and an American Petroleum Institute (API) study[2]. In both studies, the QuestFOCUS software was evaluated on technical merit (appropriateness of models for specific applications) and on model predictions for specific releases. One conclusion drawn by both studies was that the dispersion software tended to overpredict the extent of the gas cloud travel, thus resulting in too large a cloud when compared to the test data (i.e., a conservative approach).

A study prepared for the Minerals Management Service[3] reviewed models for use in modeling routine and accidental releases of flammable and toxic gases. CANARY by Quest received the highest possible ranking in the science and credibility areas. In addition, the report recommends CANARY by Quest for use when evaluating toxic and flammable gas releases. The specific models contained in the CANARY by Quest software package have also been extensively reviewed.

3.5.1 Consequence Modeling Results

This study evaluated the twenty-one release scenarios using worst-case conditions. This approach produces the maximum expected downwind hazard zones. The following parameters were applied to each potential release scenario:

Wind speed	1.5 m/s
Atmospheric stability	Pasquill-Gifford Class "F"
Air temperature	80˚F
Relative humidity	70%
Release orientation	horizontal, with the wind
Release elevation	4 feet

[1] *Evaluation of Dense Gas Dispersion Models*. Prepared for the U.S. Environmental Protection Agency by TRC Environmental Consultants Inc., East Hartford, Connecticut, 06108, EPA Contract No. 68-02-4399, May, 1991.

[2] *Hazard Response Modeling Uncertainty (A Quantitative Method)*; *Volume II, Evaluation of Commonly-Used Hazardous Gas Dispersion Models*, S. R. Hanna, D. G. Strimaitis, and J. C. Chang. Study cosponsored by the Air Force Engineering and Services Center, Tyndall Air Force Base, Florida, and the American Petroleum Institute, performed by Sigma Research Corporation, Westford, Massachusetts, September 1991.

[3] *A Critical Review of Four Types of Air Quality Models Pertinent to MMS Regulatory and Environmental Assessment Missions*, Joseph C. Chang, Mark E. Fernau, Joseph S. Scire, and David G. Strimaitis. Mineral Management Service, Gulf of Mexico OCS Region, U.S. Department of the Interior, New Orleans, Louisiana, November, 1998.

SECTION 4
WORST-CASE CONSEQUENCE MODELING RESULTS

The results of the credible worst-case consequence modeling calculations for the existing process and the proposed modifications are presented in this section.

4.1 Description of Potential Hazard Zones

For a potential accident (e.g., pipe break, hole in vessel, etc.), one particular set of release conditions/ atmospheric conditions will create the largest potential hazard zone. As an example, consider a release from the Light Naphtha Stabilizer Overhead Accumulator. This accident is a hole (rupture) in the liquid portion of the accumulator (or in any of the associated equipment handling this liquid), resulting in possible exposure to both a flammable cloud and to H_2S downwind of the release. Under the worst-case atmospheric conditions evaluated, the toxic hazard zone (as defined by the ERPG-2 concentration level) extends 350 ft downwind from the point of release. The hazard "footprint" associated with this event is illustrated in two ways in Figure 4-1. One method presents the footprint as a circle, known as a vulnerability zone, which extends 350 ft around the point of release. This presentation may be misleading since everyone within the circle cannot be simultaneously exposed to the H_2S ERPG-2 level from any single accident. A more realistic illustration of the potential hazard zone around the release point is given by the darkened cloud in Figure 4-1. The cloud area illustrates the H_2S hazard footprint that would be expected IF a rupture were to occur, AND the wind is blowing at a low speed from the north, AND stable atmospheric conditions exist, AND the release is oriented horizontally, in the direction of the wind.

4.2 Identification of Releases that Exceed Facility Fence Line

Table 4-1 presents the dispersion distances for the worst-case flammable and toxic releases for the releases evaluated under the current and proposed refinery configurations. Table 4-1 shows that about half of the selected potential releases do not have consequences that reach a facility property line, and thus do not have the ability to affect offsite populations. Of the releases that do produce offsite consequences, only one of the releases from the new system (after modifications) produces hazard zones that extend past the hazard zones for the current system that it is compared to. This one release is a rupture in the Naphtha Splitter Overhead Accumulator.

With the maximum hazard zones defined for each of the twenty-one selected releases, the potential hazard zone maps can be overlaid onto the local area. Each specific hazard zone map is rotated around the release point to form a vulnerability zone, as was presented in Figure 4-1. If the vulnerability zones for all releases evaluated in this study are plotted on the refinery plot plan, Figure 4-2 results. The cross-hatched area shown in Figure 4-2 is the new (additional) area exposed to the hazards of potential releases after the refinery modifications.

Figure 4-3 presents the same vulnerability zones as Figure 4-2, overlaid on an aerial view of the refinery and surrounding area. This helps to show the areas exposed to potential offsite consequences under the worst-case conditions evaluated in this study.

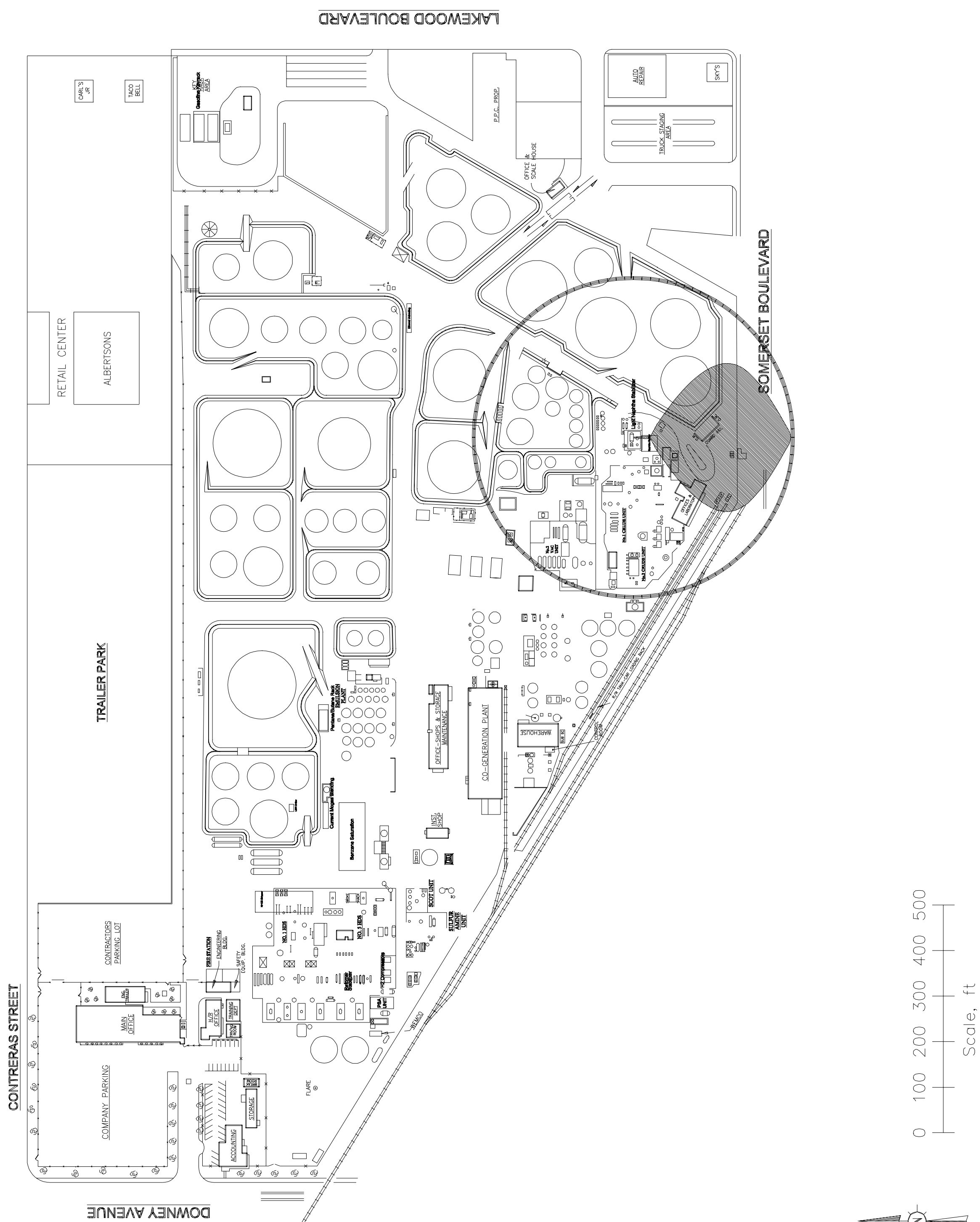

Figure 4-1
30 ppm H_2S Vulnerability Zone and Hazard Footprint
for a Rupture of the Light Naphtha Stabilizer Overhead Accumulator

Table 4-1
Release and Dispersion Results for Paramount Refinery Modification Comparisons

Comparison Number	Release From	Old System	New System	Approximate Distance (ft) to Fenceline	Maximum Distance (ft) to LFL	Maximum Distance (ft) to 30 ppm H_2S	Offsite Hazard?
1	Reformer Stabilizer Overhead Accumulator	x	x	135	620	--	Yes
	BSIU Reformate Splitter Accumulator		x	~310	445	--	Yes
	BSIU Stabilizer Accumulator		x	~310	430		Yes
2	Existing Light Naphtha Stabilizer	x		220	655	--	Yes
	Modified Light Naphtha Stabilizer		x	220	655	--	Yes
3	Existing #1 HDS Stripper Overhead	x		245	75	50	No
	Modified #1 HDS Stripper Overhead		x	245	105	185	No
	#1 HDS Stripper Reflux Accumulator		x	245	390	330	Yes
4	Light Naphtha Stabilizer Overhead Accumulator	x	x	230	590	350	Yes
	Naphtha Splitter Overhead Accumulator		x	190	700	470	Yes
5	Butane Loading Hose	x	x	310	410	--	Yes
	Gasoline Loading Hose	x	x	75	180	--	Yes
	Pentane Loading Hose		x	310	190	--	No
	Ethanol Unloading Hose		x	500	140	--	No
6	Light Naphtha at Gasoline Blending	x	x	310	290	--	No
	Butane at Gasoline Blending	x	x	310	365	--	Yes
	Pentane at Gasoline Blending		x	310	90	--	No

Table 4-1
Release and Dispersion Results for Paramount Refinery Modification Comparisons
(Continued)

Comparison Number	Release From	Old System	New System	Approximate Distance (ft) to Fenceline	Maximum Distance (ft) to LFL	Maximum Distance (ft) to 30 ppm H_2S	Offsite Hazard?
7	Reformer Stabilizer Offgas	x	x	140	60	--	No
	Reformer Produced Hydrogen	x	x	140	50	--	No
	PSA High Purity Hydrogen		x	70	65	--	No
	PSA Fuel Gas		x	70	35	--	No

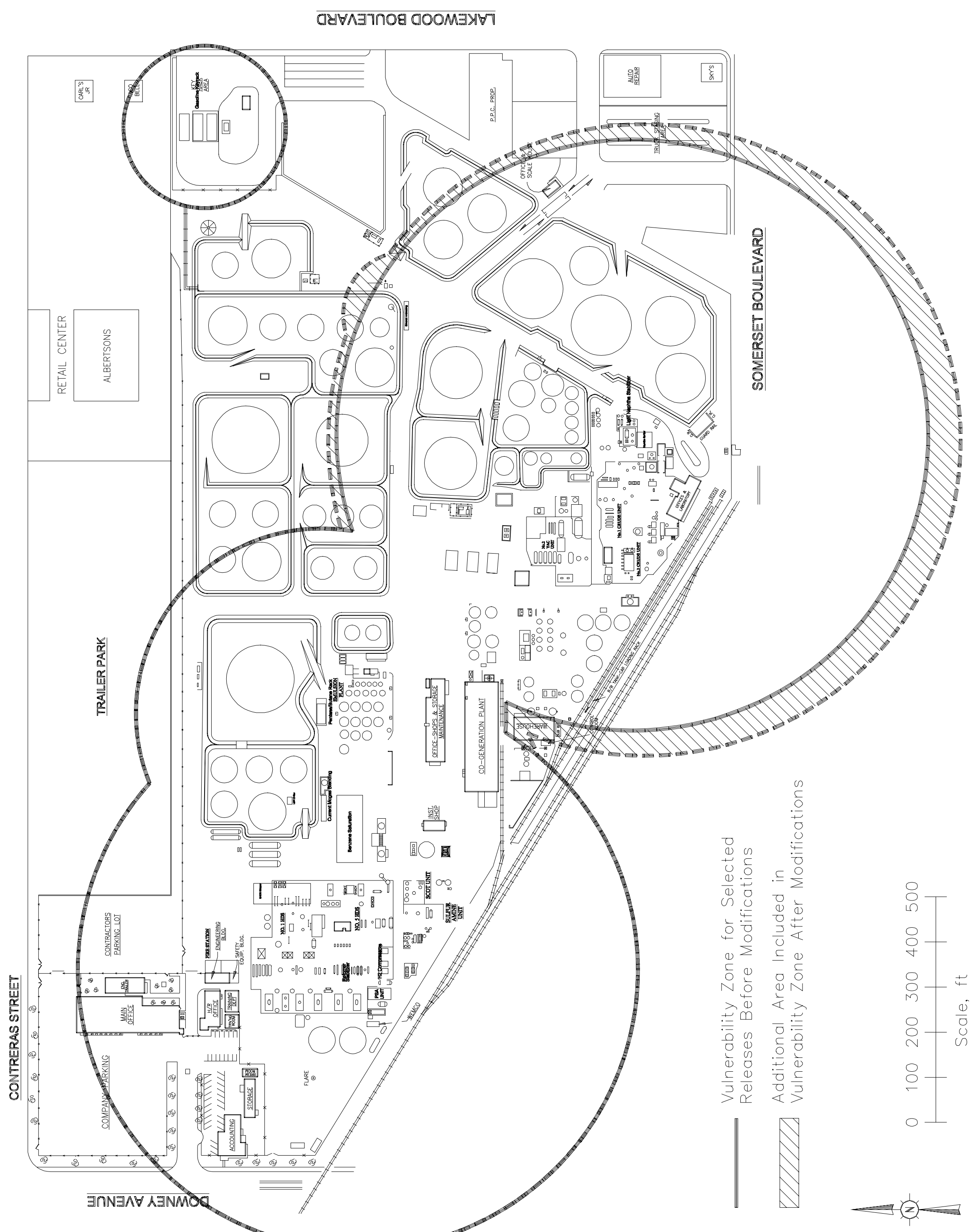

Figure 4-2
Composite Vulnerability Zone

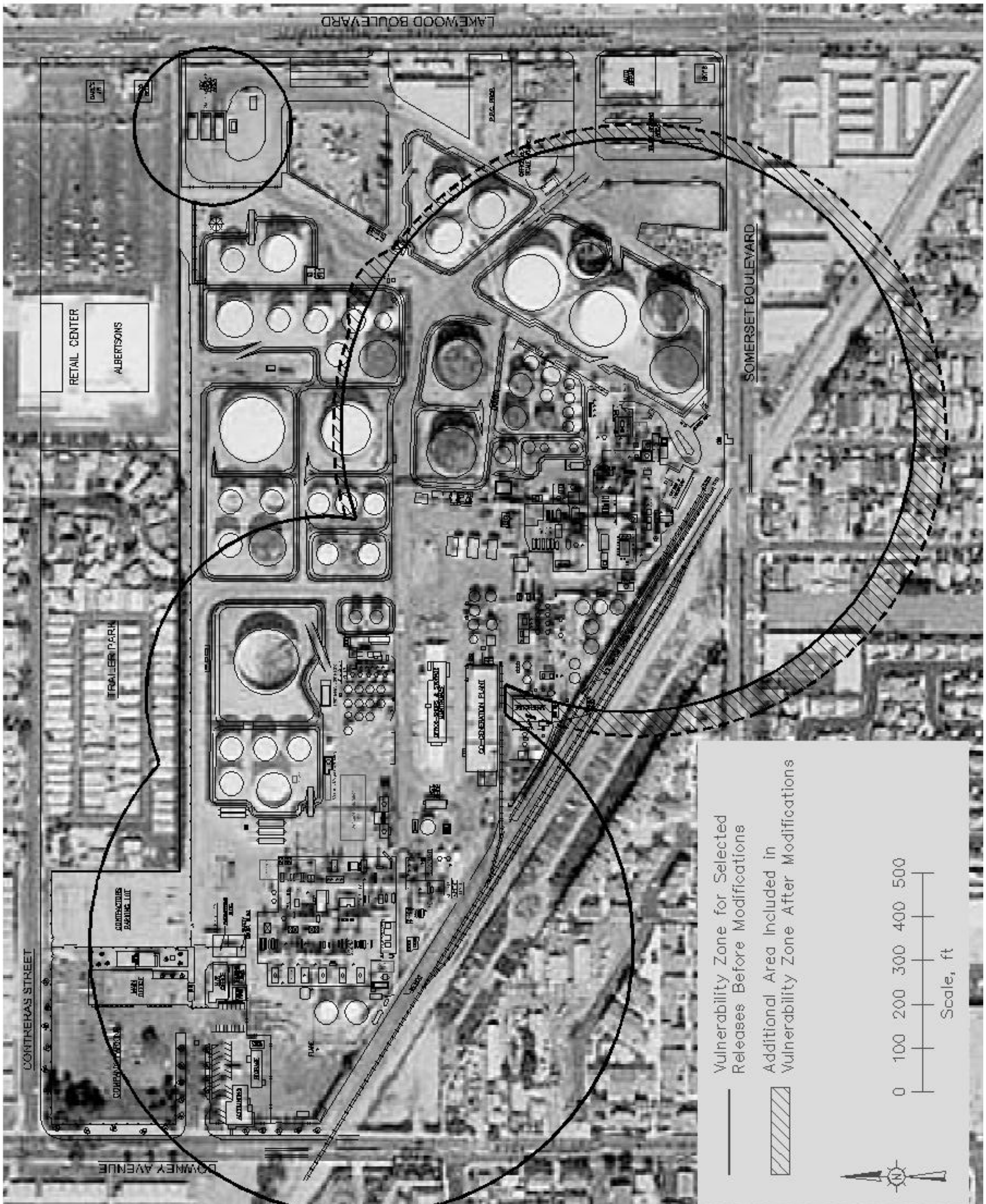

Figure 4-3
Composite Vulnerability Zone on an Aerial Photo of the Local Area

SECTION 5
CONCLUSIONS

The consequence analysis study resulted in a total of twenty-one release and dispersion calculations being evaluated under worst-case atmospheric conditions. Seven hazard zone comparisons were made in order to demonstrate the effect of the proposed configuration and operating condition modifications.

The analysis considered several refinery modifications that proved to have minimal impact on the results. These findings are summarized below.

- The addition of a combined Benzene Saturation and Isomerization Unit (BSIU) results in potential offsite exposure to flammable gas clouds, under worst-case conditions. The offsite area potentially exposed to the new hazards is smaller than areas that are currently exposed to a similar hazard from related equipment.
- Modifications to the Light Naphtha Stabilizer do not produce increased hazard zones offsite.
- Modifications to the #1 (Naphtha) HDS Stripper result in increased potential exposure offsite to flammable gas clouds or gas clouds containing H_2S. The potential hazards due to the addition of the Stripper Reflux Accumulator exceed those of the existing stripper equipment. The area exposed to these hazards falls within areas exposed by current operations (see the Reformer results in Table 4-1).
- The addition of pentane loading and ethanol unloading do not result in any new offsite hazards.
- An upgrade of the gasoline blending equipment does not result in any new offsite hazards.
- The addition a PSA unit to the refinery does not result in any new offsite impacts.

Only one of the proposed modifications exposes new offsite areas to flammable gas or H_2S hazards.

- Potential releases from the proposed Naphtha Splitter Overhead Accumulator expose new offsite areas to flammable gas hazards, when compared to the nearby Light Naphtha Stabilizer Overhead Accumulator.

As demonstrated in the comments above, although many of the refinery modifications do not impact new areas offsite when compared to current operations, some offsite areas will be exposed to a new risk if the proposed equipment is installed. Given the complexity of the modeling process and the uncertainty in producing an “exact” answer, the results in Table 4-1 should be viewed as providing a conservative upper limit of the potential hazard impacts to the flammable limit and H_2S ERPG-2 level under worst-case conditions. Focusing solely on the results under worst-case conditions does not provide a reasonable assessment of the potential risk that the refinery poses on the surrounding public. For instance, for the largest impact to occur (i.e., the impact resulting from a rupture in the Naphtha Splitter Overhead Accumulator), the hole would have to be created, AND the hole would have to be in the liquid portion of the vessel or in associated equipment handling this liquid, AND the release would have to be oriented horizontally, AND the release stream does not impact neighboring equipment, AND the winds would be low (1.5 m/s), AND the atmosphere would have to be stable (Pasquill F), AND the terrain would remain uniform over the cloud’s 700 feet of travel. It is clear that the probability of all these conditions existing at the same time is extremely low. Thus, the creation of a 700 ft flammable impact zone should not be considered probable or likely.

On the other hand, all the calculations made in this report employed the same set of worst-case conditions. This affords the comparison of one scenario to another. In this manner an apples-to-apples comparison of the existing and proposed refinery configurations can be made. When this comparison is made, it is clear that only one of the proposed modifications generates a new worst-case hazard zone. The new hazard zone is only slightly larger in extent than the hazard zone from existing refinery equipment.