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2.2 Nearby Industrial, Transportation, and Military Facilities

2.2.1 Location and Routes

VCS COL 2.0-5-A

Potential hazard facilities and routes within the 5-mile vicinity of VCS Units 1 and 2, and airports within 10 miles of VCS, are identified along with significant facilities at a greater distance in accordance with RG 1.206, RG 1.91, RG 4.7, RG 1.78, and relevant sections of 10 CFR Parts 50, 52, and 100. An investigation of the potential external hazard facilities and operations identified that within 5 miles of VCS Units 1 and 2, there are:

- No significant industrial facilities
- Ten active and two abandoned natural gas transmission pipelines
- One gasoline pipeline
- Three active and one abandoned natural gas gathering pipelines
- Seven major natural gas and/or oil fields with active extraction wells identified for further analysis (References 2.2-201 through 2.2-206)

An evaluation of major transportation routes within the 5-mile vicinity of VCS identified one navigable waterway, one road, and one railway for assessment (References 2.2-207 through 2.2-210).

A site vicinity map (Figure 2.2-201) details the following identified transportation routes within a 5-mile radius:

- Victoria Barge Canal (5.05 miles to nearest point of approach)
- U.S. Highway 77
- Union Pacific Railway

Figure 2.2-202 illustrates the following identified natural gas and chemical pipelines located within 5 miles of VCS Units 1 and 2:

<u>Natural Gas Transmission Pipelines</u>

- Gulf South Pipeline Co. L.P.—Koch Gateway Pipeline System—129
- Kinder Morgan Texas Pipeline, L.P. (Natural Gas Pipeline Company of America):
    - Gulf Coast Mainline System—Mainline #1
    - Gulf Coast Mainline System—Mainline #2
    - Tom O’Connor FL—Missouri City Jct. System
    - South Texas Laterals System—Petrotex Lateral

- Transcontinental Gas Pipeline Corp.—Mainline 26-0100 System
- Tennessee Gas Pipeline Company
    - TGP 100 System—100-1
    - TGP 100 System—100-2
    - TGP 100 System—100-3
    - TGP 100 System—Coleto Creek Line
- Aquila Southwest Pipeline Corp.—Mary Simmons System (abandoned)
- Apache Corporation—McFaddin Gathering System (abandoned)

Chemical Pipelines

- Citgo Products Pipeline Company Casa Pipeline System—Nueces Station to Victoria Station (gasoline/diesel fuel)

Natural Gas Gathering Pipelines

- Crosstex Gulf Coast Trans, LTD—Gulf Coast Transmission System
- Enerfin Field Services LLC—McFaddin and Refugio Gathering System
- Gulf South Pipeline Co. L.P.—Victoria Gathering System
- Enterprise Products Operating, LLC—System 390 (abandoned)

Figure 2.2-203 illustrates the following active natural gas and/or oil extraction fields located within 5 miles of VCS Units 1 and 2:

Natural Gas/Oil Extraction Fields

- McFaddin
- Kay Creek
- Anaqua
- Johnstone
- Wildcat (two non-contiguous fields)
- Huff

Industrial Facilities

An evaluation of nearby industrial facilities and transportation routes within 5 to 10 miles of VCS Units 1 and 2 was undertaken. The evaluation identified six industrial facilities that are significant enough to be considered for further review (Figure 2.2-201). They are:

- Air Liquide America Corporation
- INVISTA-DuPont
- Equistar Chemicals
- ConAgra International Fertilizer
- Inergy Propane, LLC
- Tennessee Gas Pipeline Station 9

Four additional roads and one additional railway are located within 5 to 10 miles of VCS. However, they are not considered significant enough to be identified as potential hazards.

Figure 2.2-204 illustrates the following identified airports and airway routes and military operations areas within 10 miles of VCS (References 2.2-211 and 2.2-212):

- Kingsville Military Operations Area

The Green Lake Ranch Airport is situated just outside of the 10-mile radius of VCS. However, because of its close proximity to the 10-mile radius, it was included for consideration.

Figure 2.2-201 illustrates one active mining and quarrying operation within 10 miles of VCS, Fordyce, Ltd., Briggs Plant—Sand and Gravel Dredging (Reference 2.2-213).

There are no identified roads, railways, navigable waterways, or activities at a distance greater than 10 miles that are significant potential hazards. The Victoria Regional Airport is situated approximately 17.7 miles northeast of VCS (Reference 2.2-214), and the closest military base is Ingleside Naval Station located in Ingleside, Texas, approximately 55 miles south of VCS (Reference 2.2-215).

2.2.2 Descriptions

2.2.2.1 Industrial Facilities

The six facilities identified for further review are:

- Air Liquide America Corporation
- INVISTA-DuPont
- Equistar Chemicals
- ConAgra International Fertilizer
- Inergy Propane, LLC

- Tennessee Gas Pipeline Station 9

Table 2.2-201 details each facility and lists its primary function, major products, and number of employees.

2.2.2.2 Description of Products and Materials

A more detailed description of onsite and associated chemicals for each of the previously cited facilities is provided in the following subsections. This description includes information about the products and materials regularly manufactured, stored, used, and transported in the VCS vicinity or onsite. In keeping with the guidance of RG 1.78, chemicals stored or situated at distances greater than 5 miles from VCS Units 1 and 2 are not considered unless they are determined to have a significant impact on the units. Only the six facilities identified herein are determined to have a possible significant impact on VCS; therefore, further analysis for facilities other than these is not required.

2.2.2.2.1 Onsite Chemicals

The chemical materials expected to be stored onsite at VCS are identified in Table 2.2-202. These chemicals were identified from those listed for the proposed unit in the Reference Combined License Application (R-COLA) as well as from chemicals expected to be used in the VCS water treatment system. They will be stored in similar locations and in similar amounts as those stated in the R-COLA. Table 2.2-202 identifies the anticipated system in which the chemical will be used or storage location and quantity of each chemical/material. Potentially toxic, flammable, and/or explosive chemicals onsite are evaluated for possible effects on the safe operation and shutdown of VCS Units 1 and 2.

2.2.2.2.2 Industrial Facilities

Air Liquide America Corporation

Air Liquide America Corporation is located approximately 7.4 miles east of VCS Units 1 and 2. Air Liquide has two separation units that produce oxygen, nitrogen, and argon for use in the food and medical industries as well as for other industrial applications (Reference 2.2-216). At the 30-acre Air Liquide Victoria County plant, there are seven employees. This facility uses anhydrous ammonia and chlorine in the production of air products; however, because of the small amounts of these materials stored onsite and the facility's distance from VCS, stored materials do not present a hazard.

Air Liquide receives and ships materials primarily by truck. Products and materials are shipped and received via State Highway 185, McCoy Road, and Old Bloomington Road. The truck transport route does not approach within 5 miles of VCS Units 1 and 2. As provided in RG 1.78, chemicals stored or situated at distances greater than 5 miles from the plant do not require consideration because if a release occurs at such a distance, atmospheric dispersion will dilute and disperse the incoming plume to such a degree that either toxic limits will never be reached or there would be sufficient time for the control room operators to take appropriate action.

INVISTA-DuPont Victoria

The center of the INVISTA-DuPont Victoria plant is located approximately 6 miles northeast of VCS. At its closest point, the INVISTA-DuPont Victoria plant is approximately 5.4 miles northeast of VCS. INVISTA, formerly DuPont Textiles and Interiors, was purchased by Koch Industries in April 2004 (Reference 2.2-217). The ethylene copolymers portion of the plant is still operated by DuPont, who acts as a tenant at the larger INVISTA facility. The DuPont ethylene copolymers plant consists of 38 acres and produces low-density polyethylene resins (Reference 2.2-218). The DuPont Victoria plant employs approximately 90 people.

The INVISTA site consists of 4500 acres; approximately 1100 acres are used for manufacturing and waste treatment, and the remaining land is wildlife habitat (Reference 2.2-219). The facility produces nylon intermediates, including hexamethylenediamine, adipic acid, and dodecanedioic acid and employs approximately 555 personnel (Reference 2.2-220).

The most direct truck route to this facility is via State Highway 185. {The most direct rail transport route is the Union Pacific Railway, which travels north to Victoria and south to Bloomington. The Victoria Barge Canal also serves as a transport route for materials to and from the INVISTA-DuPont facility. The truck and railway routes do not approach within 5 miles of VCS Units 1 and 2. At its closest approach, the Victoria Barge Canal is approximately 5 miles from VCS; therefore, chemicals transported by INVISTA-DuPont along the Victoria Barge Canal are considered in an analysis of waterway transport hazards.

As provided in RG 1.78, chemicals stored or situated at distances greater than 5 miles from the plant do not require consideration. However, because of the size and location of this facility as well as the quantities of stored chemicals, it was considered for further review. The risk management plan for INVISTA-DuPont indicates that anhydrous ammonia is the primary toxic chemical of concern, and butadiene presents the primary flammable concern. Monitoring and mitigation systems such as detectors, dikes, and deluge systems are in place at the INVISTA-DuPont facility to minimize the impacts of a chemical release. There is also an emergency response plan in place to notify community members and emergency responders as appropriate (Reference 2.2-220). Furthermore, as stated in RG 1.78, if a release occurs at such a distance, atmospheric dispersion will dilute and disperse the incoming plume to such a degree that either toxic limits will never be reached or there would be sufficient time for the control room operators to take appropriate action. Therefore, with the exception of those materials transported along the Victoria Barge Canal, no further analysis is required.

Equistar Chemicals

Equistar Chemicals, a subsidiary of the Lyondell Chemical Company, is located 6.2 miles northeast of VCS. The Equistar Victoria Plant covers approximately 33 acres and has 84 full-time employees. Equistar is a producer of high-density polyethylene (HDPE) resins that are used to make housewares, building supplies, automotive parts, food packaging, personal care items, and grocery bags (Reference 2.2-221).

The most direct truck route to the facility is via State Highway 185. The most direct rail transport route is the Union Pacific Railway, which travels north to Victoria and south to Bloomington. The Victoria Barge Canal also serves as a transport route for materials to/from the Equistar facility. The truck and railway routes do not approach within 5 miles of VCS Units 1 and 2. At its closest approach, the Victoria Barge Canal is approximately 5 miles from VCS; therefore, chemicals transported by Equistar along the Victoria Barge Canal are considered in an analysis of waterway transport hazards.

As provided in RG 1.78, chemicals stored or situated at distances greater than 5 miles from the plant do not require consideration because if a release occurs at such a distance, atmospheric dispersion will dilute and disperse the incoming plume to such a degree that either toxic limits will never be reached or there would be sufficient time for the control room operators to take appropriate action. In addition, the probability of a plume remaining within a given sector for a long period of time is quite small. Therefore, with the exception of those materials transported along the Victoria Barge Canal, no further analysis is required.

ConAgra International Fertilizer

ConAgra International Fertilizer is located 7.6 miles northeast of VCS. The ConAgra facility has four full-time employees and produces liquid fertilizer solutions for agricultural use (Reference 2.2-222).

ConAgra ships and receives materials by truck, rail, and barge. Trucks transport materials from State Highway 185 to FM 1432. The Union Pacific Railway from Bloomington is used to transport phosphoric acid and anhydrous ammonia. The Victoria Barge Canal also serves as a transport route for liquid fertilizer products shipped from the ConAgra facility. The truck and railway routes do not approach within 5 miles of VCS Units 1 and 2. At its closest approach, the Victoria Barge Canal is approximately 5 miles from VCS; therefore, chemicals transported by ConAgra along the Victoria Barge Canal are considered in an analysis of waterway transport hazards.

As provided in RG 1.78, chemicals stored or situated at distances greater than 5 miles from the plant do not require consideration because if a release occurs at such a distance, atmospheric dispersion will dilute and disperse the incoming plume to such a degree that either toxic limits will never be reached or there would be sufficient time for the control room operators to take appropriate action. In addition, the probability of a plume remaining within a given sector for a long period of time is quite small. Therefore, with the exception of those materials transported along the Victoria Barge Canal, no further analysis is required.

Inergy Propane, LLC

A subsidiary of Inergy Propane, Independent Propane is located 7.7 miles northwest of VCS. Inergy Propane is a propane distribution company that serves residential, agricultural, and industrial propane customers (Reference 2.2-223). There are no permanent employees at this facility, and the only reported onsite material is a 30,000-gallon bulk propane storage tank.

As provided in RG 1.78, chemicals stored or situated at distances greater than 5 miles from the plant do not require consideration because if a release occurs at such a distance, atmospheric dispersion will dilute and disperse the incoming plume to such a degree that either toxic limits will never be reached or there would be sufficient time for the control room operators to take appropriate action. In addition, the probability of a plume remaining within a given sector for a long period of time is quite small.

Tennessee Gas Pipeline Station 9

The Tennessee Gas Pipeline Station 9 is located 7.2 miles northeast of VCS. A natural gas compressor station, this facility has seven employees. All chemicals stored at this facility are transported by road via FM 1432 to State Highway 185. The truck transport route does not approach within 5 miles of VCS. The natural gas (methane) is transported via pipeline.

As provided in RG 1.78, chemicals stored or situated at distances greater than 5 miles from the plant do not require consideration because if a release occurs at such a distance, atmospheric dispersion will dilute and disperse the incoming plume to such a degree that either toxic limits will never be reached or there would be sufficient time for the control room operators to take appropriate action. In addition, the probability of a plume remaining within a given sector for a long period of time is quite small. Additionally, no impacts from a methane gas release at this facility will occur beyond the Victoria Barge Canal (located 5 miles from VCS). Therefore, no further analysis is required.

2.2.2.3 Description of Natural Gas/Petroleum Pipelines and Fields

2.2.2.3.1 Natural Gas Transmission Pipelines

Thirteen active natural gas pipelines are identified within a 5-mile radius of VCS. There are 10 natural gas transmission pipelines and 3 natural gas gathering pipelines (Figure 2.2-202). A more detailed description of each of these pipelines is presented in the following subsections and in Table 2.2-206. This description includes pipe size, operating pressure, depth of burial, location, and distance between isolation valves where available.

Transcontinental Gas Pipeline Corporation

The closest pipeline to VCS is a 26-inch natural gas transmission line operated by Transcontinental Gas Pipeline Corporation (Reference 2.2-205). The pipeline is part of the Mainline 26-0100 system and runs through the VCS site between the switchyard and the power block area (Figure 2.2-202). The pipeline is buried at a depth of 3 feet and has an operating pressure of 700 pounds per square inch (psig).

Gulf South Pipeline Company L.P.

The Gulf South Pipeline Company, L.P., operates a natural gas transmission pipeline that passes approximately 3.6 miles south of VCS as shown in Figure 2.2-202. The pipeline is part of the Koch Gateway Pipeline System and is 30 inches in diameter (Reference 2.2-205). Transcontinental Gas Pipeline Corporation's pipeline presents a greater potential hazard than the Gulf South Company's pipeline because of its proximity to VCS, and as such, no further analysis of this pipeline is performed.

Kinder Morgan Texas Pipeline, L.P. (Natural Gas Pipeline Company of America)

Kinder Morgan Texas Pipeline, L.P., operates four natural gas transmission pipelines within a 5-mile radius of VCS (Reference 2.2-205). The Gulf Coast Mainline #1 pipeline passes approximately 1.3 miles southeast of VCS and runs beneath the VCS cooling basin (Figure 2.2-202). The pipeline is 26 inches in diameter, operates at a pressure of 900 psig, and is buried at a depth of 45 inches.

The Gulf Coast Mainline #2 pipeline is located adjacent to the Gulf Coast Mainline #1 pipeline and passes approximately 1.3 miles southeast of VCS. This pipeline also runs beneath the VCS cooling basin (Figure 2.2-202). The pipeline is 30 inches in diameter, operates at a pressure of 900 psig, and is buried at a depth of 45 inches.

The Tom O'Connor FL–Missouri City Junction pipeline passes approximately 3.7 miles southeast of VCS (Figure 2.2-202). The pipeline is 30 inches in diameter, operates at a pressure of 795 psig, and is buried at a depth of 30 inches.

The South Texas Lats. Petrotex Lateral subsystem is a 4.5-inch-diameter natural gas transmission line that passes within approximately 4.1 miles of VCS (Figure 2.2-202). This line serves the Anaqua Field (Reference 2.2-205). Potential hazards from this line are bounded by the natural gas transmission pipelines because of the larger volume of natural gas in the transmission pipelines.

Transcontinental Gas Pipeline Corporation's pipeline presents a greater potential hazard than Kinder Morgan's Gulf Coast Mainline #1, Gulf Coast Mainline #2, Tom O'Connor FL–Missouri City Junction, or Petrotex Lateral pipelines because of its proximity to VCS. Therefore, no further analysis of these pipelines is performed.

Tennessee Gas Pipeline Company

Tennessee Gas Pipeline Company operates four natural gas transmission pipelines within a 5-mile radius of VCS. All four of the pipelines are part of the Tennessee Gas Pipeline 100 system and include pipelines 100-1, 100-2 100-3, and the Coleto Creek Line. {The 100-1 pipeline passes approximately 0.67 miles northwest of VCS (Figure 2.2-202). The 100-1 pipeline is 24 inches in diameter, has a maximum operating pressure of 750 psig, and is buried at a depth of 36 inches. The 100-2 pipeline runs parallel with 100-1 and also passes approximately 0.67 miles northwest of VCS. The 100-2 pipeline is 24 inches in diameter, has a maximum operating pressure of 750 psig, and is buried at a depth of 36 inches. The 100-3 pipeline passes approximately 0.64 miles northwest of VCS (Figure 2.2-202). The 100-3 pipeline is 30 inches in diameter, has a maximum operating pressure of 750 psig, and is buried at a depth of 36 inches. The Coleto Creek Line branches from, and runs north of, the 100-2 pipeline. This 12.75-inch-diameter pipeline is located approximately 0.86 miles west of VCS (Reference 2.2-205).

The Transcontinental Gas Pipeline Corporation's pipeline presents a greater potential hazard than the Tennessee Gas Pipeline Company's 100-1, 100-2, 100-3 or Coleto Creek Line pipelines because of its proximity to VCS. Therefore, no further analysis of these pipelines is performed.

2.2.2.3.2 Chemical Pipelines

Citgo Products Pipeline Company operates a pipeline that transports refined products (gasoline and diesel fuel). The Casa Pipeline System–Nueces Station to Victoria Station pipeline at its closest approach is approximately 3.3 miles northeast of VCS (Figure 2.2-202) (Reference 2.2-205). The pipeline is a steel line that ranges from 8 to 10 inches in diameter, operates at a maximum pressure of 625 psig, and is buried at an average depth of 2.5 feet.

2.2.2.3.3 Natural Gas Gathering Pipelines

Crosstex Gulf Coast Transmission, LTD

Crosstex Gulf Coast Transmission, LTD operates a 14-inch diameter natural gas gathering line that passes approximately 4.0 miles southeast of VCS (Figure 2.2-202) (Reference 2.2-205). Potential hazards from this line are bounded by the natural gas transmission pipelines because of the larger volume of natural gas in the transmission pipelines and their closer proximity to VCS.

Enerfin Field Services, LLC

Enerfin Field Services, LLC operates a 4.5-inch diameter natural gas gathering line that passes approximately 4.8 miles southeast of VCS (Figure 2.2-202) (Reference 2.2-205). This gas gathering line is part of the McFaddin and Refugio Gathering System. Potential hazards from this line are bounded by the natural gas transmission pipelines due to the larger volume of natural gas in the transmission pipelines and their closer proximity to VCS.

Gulf South Pipeline Company, L.P.

Gulf South Pipeline Company, L.P. operates a 4.5-inch diameter natural gas gathering line that passes approximately 1.5 miles east of VCS (Figure 2.2-202). This gas gathering line is part of the Victoria Gathering System and serves the McFaddin Field (Reference 2.2-205). Potential hazards from this line are bounded by the natural gas transmission pipelines because of the larger volume of natural gas in the transmission pipelines and their closer proximity to VCS.

2.2.2.3.4 Gas/Oil Fields

There are seven major natural gas/oil extraction fields located within the 5-mile vicinity of VCS. Many of the wells in these fields have been plugged and are no longer in operation. Active gas wells, oil wells, and gas/oil wells, as well as the approximate extent of the fields, are shown in Figure 2.2-203. Additionally, the locations of permitted wells are identified (Reference 2.2-206). The closest active well is located approximately 0.90 miles east of VCS, and the closest permitted location is approximately 0.63 miles south of VCS. Potential hazards from these wells are bounded by the natural gas transmission lines because of the larger volume of natural gas in the transmission lines and their closer proximity to VCS.

2.2.2.4 Description of Waterways

VCS Units 1 and 2 are located approximately 5 miles west of the Victoria Barge Canal. The Canal traverses 35 miles from the Port of Victoria Turning Basin to the Gulf Intracoastal Waterway. The Canal is maintained to a depth of 12 feet and width of 125 feet (Reference 2.2-224). The Port of Victoria Turning Basin is located at the northernmost end of the Victoria Barge Canal, approximately 6.2 miles northeast of VCS, and is also served by the Union Pacific Railway with access to State Highway 185 (Figure 2.2-201).

During the 12-month period from January 2005 through December 2005, a total of 2576 inbound and 2599 outbound trips were recorded along the canal. These vessels transported a total of 3244 thousand tons of commodities along the 35 mile stretch of the Canal (Reference 2.2-210). Table 2.2-205 identifies the hazardous materials transported near VCS.Makeup water for VCS operation is drawn from the Guadalupe-Blanco River Authority (GBRA) Calhoun Canal System. The GBRA Calhoun Canal System draws fresh water from the Guadalupe River, a waterway located about 4 miles to the east of the VCS site. It provides water to agriculture, industry, and water treatment and supply facilities. Because the Calhoun Canal System is a non-navigable waterway, damage to the raw water makeup (RWMU) system intake structure from a collision is unlikely.

2.2.2.5 Description of Highways

Victoria County is traversed by several highways. There is a single highway within 5 miles of VCS. U.S. Highway 77, located west of the VCS site, transverses in a north-to-south direction. At its closest point, U.S. Highway 77 is approximately 0.8 miles from the center point between the Unit 1 and 2 reactor buildings. The western-most property line of the VCS site is immediately adjacent to U.S. Highway 77. U.S. Highway 77 serves to connect Victoria, Texas, with Corpus Christi, Texas, to the south (Reference 2.2-207).

To the east of the VCS site, State Highway 185 (also known as FM 404) runs in a north-to-south direction; at its closest point, it is approximately 8.5 miles from VCS. State Route 185 serves to link facilities along Old Bloomington Road to Victoria, Texas, and the interstate highway system (Reference 2.2-207).

State Route 239, located south of the VCS site, runs in an east-to-west direction and is located approximately 6.6 miles from VCS. To the north of the VCS site, U.S. Highway 59 runs in an east-to-west direction. At its closest point, U.S. Highway 59 is located approximately 7.8 miles from VCS. State Route 91, located approximately 7.3 miles north of VCS, serves to connect U.S. Highway 77 north of the site to U.S. Highway 59 (Reference 2.2-207).

A traffic corridor analysis serves to identify the hazardous materials transported in the vicinity of VCS. Three commodity flow studies are identified for use in the corridor analysis along with EPA Tier II facilities along U.S. Highway 77.

In 1996, the Victoria City/County Local Emergency Planning Commission (LEPC) conducted a 4-week survey of hazardous materials transported on local streets and highways (Reference 2.2-225). The study consisted of visual observations of cargo trucks and recorded the hazardous material identification placards they displayed. An assessment of truck and rail transport of hazardous materials conducted in 1998 by the Corpus Christi/Nueces County LEPC identified seven serious chemicals transported in the area (Reference 2.2-226). Risk was identified for citizens along U.S. Highway 77. A freight and hazardous materials movement study prepared in 2004 for the Corpus Christi Metropolitan Planning Organization modeled commodity movements by truckload between Corpus Christi, Houston, and Dallas. This study includes movements along U.S. Highway 77 (Reference 2.2-227).

Additionally, hazardous products and materials stored at EPA Tier II facilities along U.S. Highway 77 within the vicinity of VCS were evaluated and included for analysis of possible roadway hazards (References 2.2-201 through 2.2-204).

Based on the commodity flow studies and the distribution of EPA Tier II facilities within a 20-mile radius of VCS, the most likely chemicals to be transported along U.S. Highway 77 in the vicinity of VCS are identified. Table 2.2-203 identifies the most commonly transported hazardous materials along U.S. Highway 77.

2.2.2.6 **Description of Railroads**

The Union Pacific Railway passes through the towns of Bloomington and Vidaurri (Figure 2.2-201). At its closest approach, the railway is located approximately 3.9 miles south of VCS. In addition to Union Pacific, this line is also used by Burlington Northern Santa Fe and Kansas City Southern railroads. The railway does not support passenger service.

This railway will provide rail access to the VCS site. The track will be connected to the southwestern corner of the site area, and a rail spur will run north alongside the western boundary of the cooling basin. The spur to the site will traverse approximately 4.5 miles.

Approximately 48,500 shipments of hazardous materials are transported yearly along the section of the railway within the 5-mile vicinity of VCS. Table 2.2-204 identifies the most frequently transported hazardous materials near VCS.

2.2.2.7 Description of Airports and Airways

Airports

One airport, the privately owned Green Lake Ranch, is located approximately 10 miles east of the VCS site (Figure 2.2-204). The runway is 4390 feet long by 60 feet wide and is asphalt (Reference 2.2-212). Flights from this private airport are characterized as sporadic; as such, no further analysis is warranted.

The Victoria Regional Airport is located approximately 17.7 miles northeast of VCS. This public airport has four asphalt runways and a helipad. For the 12-month period ending December 2006, aircraft operations at the Victoria Regional Airport averaged 111 operations per day (Reference 2.2-214).

Airways

VCS Units 1 and 2 are located within the Kingsville Military Operations Area (MOA) (Figure 2.2-204). There are approximately 421 flight operations per year in the Kingsville MOA within the site vicinity. The Kingsville MOA is restricted to military flight operations; therefore, there are no commercial or general aviation flights in the vicinity of VCS. Naval Air Station Kingsville, located approximately 89 miles southwest of the VCS site, is responsible for the Kingsville MOA and maintains records pertaining to its use by all military facilities. No operations carrying bombs or live ordinance occur near VCS.

2.2.2.8 Description of Mining Activities

There are no mining activities within 5 miles of VCS. The nearest mining activity is the Briggs Plant, a sand and gravel dredging operation owned by Fordyce, Ltd. located 7.2 miles northeast of VCS (Reference 2.2-213). There are no blasting explosives or hazardous chemicals used or stored on the Briggs Plant property.}

2.2.2.9 Military Facilities

There are no military facilities within a 20-mile radius of VCS. The nearest military facility is Ingleside Naval Station, which is approximately 55 miles south of VCS (Reference 2.2-215). Because of its distance from VCS, no further evaluation is required.

2.2.2.10 Projections of Industrial Growth

DuPont Victoria is planning a $15 million expansion of the ethylene copolymers facility to implement distributed control systems and increase output through process improvement and additional equipment. The expansion will provide for an additional 10 employees and will result in an increased production capacity of 200 million pounds (Reference 2.2-228).

Lone Star Ethanol is expected to begin construction of an ethanol plant at the Port of Victoria during 2008. The new facility will be located approximately 6.5 miles northeast of VCS and have approximately 60 full-time employees (References 2.2-229 and 2.2-230). Additionally, the Port of Victoria is also one of the sites being considered for a 350-acre biodiesel plant. The plant would produce biodiesels from vegetable and plants oils. The plant is expected to have 30 to 40 full-time employees (Reference 2.2-231). No other projections of industrial growth within a 10-mile radius of VCS were identified.

2.2.3 Evaluation of Potential Accidents

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An evaluation of the information provided in Subsections 2.2.1 and 2.2.2 for potential accidents that should be considered as design-basis events, and the potential effects of these accidents on the nuclear plant in terms of design parameters (e.g., overpressure, missile energies) and physical phenomena (e.g., concentration of flammable or toxic clouds outside building structures), was performed in accordance with the requirements in 10 CFR 20, 52.79, 50.34, 100.20, and 100.21 using the guidance contained in RGs 1.78, 1.91, 4.7, and 1.206.

2.2.3.1 Determination of Design-Basis Events

RG 1.206 states that design-basis events internal and external to the nuclear plant are defined as those accidents that have a probability of occurrence on the order of magnitude of 10^{-7} per year or greater with potential consequences serious enough to affect the safety of the plant to the extent that the guidelines in 10 CFR Part 100 could be exceeded. The following accident categories are considered in selecting design-basis events: explosions, flammable vapor clouds (delayed ignition), toxic chemicals, aircraft crashes, fires, collisions with the intake structure, and liquid spills. The postulated accidents within these categories are analyzed at the following locations:

- Onsite Chemical Storage
- Transcontinental Gas Pipeline Corporation
- Victoria Barge Canal
- U.S. Highway 77
- Union Pacific Railway
- Kingsville MOA

2.2.3.1.1 Explosions

Accidents involving detonations of explosives, munitions, chemicals, liquid fuels, and gaseous fuels are considered for facilities and activities either onsite or within the vicinity of VCS where such materials are processed, stored, used, or transported in quantity. The effects of explosions are a concern in analyzing the structural response to blast pressures. The effects of blast pressure from explosions from nearby railways, highways, navigable waterways, or facilities to safety-related plant structures were evaluated to determine if the explosion would have an adverse effect on plant operation or would prevent safe shutdown of the plant.

The allowable and actual distances of hazardous chemicals transported or stored are evaluated in accordance with RG 1.91. RG 1.91 cites 1 psi as a conservative value of peak positive incident overpressure, below which no significant damage would be expected. Conservative assumptions are used in determining the “safe distance” (i.e., the minimum separation distance required for an explosive force to not exceed 1 psi peak incident pressure). RG 1.91 defines this safe distance by the Hopkinson Scaling Law relationship (Reference 2.2-232) as:

$$R = kW^{1/3} \qquad \text{(Equation 2.2-1)}$$

R is the distance in feet from an explosive charge of W pounds of TNT, and k is the scaled ground distance constant at a given overpressure. For 1 psi, k is equal to 45 feet per pound$^{1/3}$.

The methodology for the explosion analyses is selected depending upon the phase of the chemical during storage and/or transportation (i.e., liquid, pressurized gas, liquefied gas, solid).

For a solid substance not intended for use as an explosive but subject to accidental detonation, RG 1.91 states that it is conservative to use a TNT mass equivalent (W) in Equation 2.2-1 equal to the cargo mass.

For pressurized and liquefied gases, the TNT mass equivalent (W) is determined according to NUREG-1805 guidance such that:

$$W = (M_{vapor} \times \Delta H_c \times Y_f) / \Delta H_{c,TNT} \qquad \text{(Equation 2.2-2)}$$

M_{vapor} is the flammable vapor mass (pounds), ΔH_c is the heat of combustion of the chemical (Btu per pound), Y_f is the explosion yield factor, and $\Delta H_{c,TNT}$ is the heat of combustion of TNT (Btu per pound) (Reference 2.2-233). The entire mass of the pressurized or liquefied gas is considered flammable because a sudden tank rupture would involve the release of a majority of the contents in the vapor phase. The yield factor is an estimation of the explosion efficiency, or a measure of the portion of the flammable material participating in the explosion. An explosion yield factor of 100% is applied to account for an in-vessel confined explosion (Reference 2.2-233). In reality, only a small portion of the vapor within the flammability limits would be available for combustion and potential explosion, and a 100% yield factor is not achievable (Reference 2.2-234). Therefore, this is a conservative assumption.

For chemicals stored or transported as liquids at atmospheric conditions, the guidance for determining the TNT equivalent mass (W) in RG 1.91 is not appropriate because RG 1.91 is limited to solid explosives and hydrocarbons liquefied under pressure. In the case of liquids, only the material in the vapor phase between the upper flammability limit (UFL) and lower flammability limit (LFL) is available to sustain an explosion (Reference 2.2-235). Under atmospheric conditions, a chemical in the vapor phase cannot occupy the same volume as an equal mass of the chemical in the liquid phase. Further, upon release of the contents of a vessel filled with a chemical that is liquid at atmospheric conditions, instantaneous vaporization of the contents would not occur. Therefore, for liquids at atmospheric conditions, only the volume of vapor at the UFL capable of occupying the largest vessel is considered available for combustion (M_{vapor}), and an explosion yield factor (Y_f) of 100% is applied to account for an in-vessel confined explosion (Reference 2.2-233).

The hazardous materials located onsite at VCS—as well as those potentially transported by pipeline, via the Victoria Barge Canal (Table 2.2-207), via U.S. Highway 77 (Table 2.2-208), and by the Union Pacific Railway (Table 2.2-209)—are evaluated to ascertain whether they have the potential to explode. The effects of these explosion events from both internal and external sources are summarized in Table 2.2-210 and are described in the following subsections relative to the release source.

2.2.3.1.1.1 Onsite Chemicals

An analysis of the onsite chemicals conducted using the TNT mass equivalency methodologies as described in Subsection 2.2.3.1.1 has been previously conducted in the R-COLA. The results of the R-COLA are assumed to apply to VCS Units 1 and 2 because the chemicals will be stored in similar locations and quantities. These results indicate that the safe distances are less than the minimum separation distances from the nearest safety-related structure to the onsite storage location for all explosive chemicals. In addition to the chemicals analyzed in the R-COLA, a 25% sodium bisulfite solution will be onsite at VCS. However, the sodium bisulfite solution does not present an explosion hazard (Reference 2.2-251). Therefore, an explosion from hazardous materials stored onsite will not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.1.1.2 Pipelines

Transcontinental Gas Pipeline Corporation operates a natural gas transmission pipeline within the vicinity of VCS. This pipeline is the closest to VCS Units 1 and 2 and represents the bounding condition for a pipeline explosion. The nearest safety-related structure, the Unit 1 control room, is 963 feet away from the analyzed release point, the closest approach of the nearest natural gas transmission pipeline. Flame Acceleration Simulator (FLACS) is privately distributed software that can be used to model explosions and fires resulting from several different types of release (Reference 2.2-236). FLACS is used to model a worst-case scenario involving the immediate deflagration of the vapor coming out of a leaking pipe at the pipe break, creating an explosion and ensuing flare.

In this worst-case scenario, it is assumed that the pipe has burst open, leaving the full cross-sectional area of the pipe completely exposed to the air. The mass flow rate out of both sections of the sheared pipe was assumed to be the same. Further, it is conservatively assumed that the release rate remains constant and that the duration of the release is sufficiently long such that steady state is achieved. The scenario is modeled such that an ignition source exists at the break point and an explosion occurs 0.25 seconds after the break occurs and continues until after the release stops and the flare ceases to burn. This is also a conservative assumption because it does not take into account any dispersion that would decrease the amount of potential flammable vapor. The heat flux generated by the flame at the Unit 1 control room is also evaluated.

The maximum overpressure at the pipe break produced by the flammable stream is 0.435 psi. This is less than the 1 psi level of concern established by RG 1.91. Therefore, the overpressure at the Unit 1 control room resulting from an explosion as the result of immediate deflagration of natural gas vapor resulting from a pipeline rupture is not significant. The results indicate that an explosion from such an event in the Transcontinental Gas Pipeline Corporation's natural gas transmission pipeline would not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

Analysis of the heat flux generated at the Unit 1 control room by the deflagration of natural gas vapor indicates that the flame reaches temperatures of 2300ºF, resulting in a heat flux within the flame of 1600 kW/m^2. This produces a heat flux at the Unit 1 control room of 6.66 kW/m^2. This is well below the heat flux necessary to spontaneously ignite wood after prolonged exposure (29 kW/m^2) (Reference 2.2-235). Therefore, the flame will have no adverse effect on the Unit 1 control room. However, the flame can reach heights of greater than 195 m (640 ft); thus, equipment (e.g., power cables) directly above the pipeline may be affected. As discussed in Subsection 2.2.3.1.2.2, this pipeline will be rerouted such that a safe distance from VCS is achieved.

2.2.3.1.1.3 Waterway Traffic

The nearest safety-related structure, the VCS Unit 2 control room, is located approximately 26,664 feet from the Victoria Barge Canal. The Canal spans 35 miles and connects the Port of Victoria Turning Basin with the Gulf Intracoastal Waterway (Reference 2.2-224). Table 2.2-205 details the hazardous materials potentially transported along the Victoria Barge Canal. The materials identified for further analysis with regard to explosion potential are: acetone, acetone cyanohydrin, acrylonitrile, butadiene, cyclohexane, cyclohexanone, gasoline, hexamethylenediamine, and propylene. The maximum quantity of all chemicals identified assumed to be carried on a vessel is 10,000,000 pounds as provided in RG 1.91.

An analysis for the identified chemicals is conducted using the TNT mass equivalency methodologies as described in Subsection 2.2.3.1.1. The results indicate that the safe distances are less than the minimum separation distances from the VCS Unit 2 control room to the Victoria Barge Canal for all of the identified chemicals (Table 2.2-210). Propylene results in the largest safe distance, 20,779 feet, which is less than the distance of 26,664 feet to the nearest safety-related structure for VCS Units 1 and 2. Therefore, an explosion from hazardous materials transported along the Victoria Barge Canal will not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.1.1.4 Highways

Table 2.2-203 details the hazardous materials potentially transported on U.S. Highway 77. The materials identified for further analysis with regard to explosion potential are: acetylene, gasoline, hydrogen sulfide, methanol, methyl cyanide, natural gas (methane), propane, and sodium hydrosulfite. With the exception of acetylene, the maximum quantity of the identified chemicals potentially transported on the roadway is 50,000 pounds as provided in RG 1.91. Acetylene is transported in cylinders (References 2.2-237 and 2.2-238). It was conservatively assumed that 8 cubic meters of acetylene at 250 psig is equivalent to 144 cubic meters at atmospheric pressure.

An analysis for the identified chemicals is conducted using the TNT mass equivalency methodologies as described in Subsection 2.2.3.1.1. The nearest safety-related structure, the VCS Unit 1 reactor building, is located approximately 4076 feet from U.S. Highway 77 at its closest point of approach. The results indicate that the safe distance is less than the minimum separation distance from the VCS Unit 1 reactor building to U.S. Highway 77 for any of the identified chemicals (Table 2.2-210). Natural gas (methane) resulted in the largest safe distance, 3660 feet, which is less than the distance of 4076 feet to the nearest safety-related structure for VCS Units 1 and 2. Therefore, an explosion from hazardous materials potentially transported on U.S. Highway 77 will not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.1.1.5 Railroads

The nearest safety-related structure, the VCS Unit 1 Fuel Building, is located approximately 20,547 feet from the Union Pacific Railway. Table 2.2-204 details the hazardous materials frequently transported on the Union Pacific Railway. The materials identified for further analysis with regard to explosion potential are: 1,1-difluoroethane, acetaldehyde, acetone, benzene, butyraldehyde, carbon bisulphide, gasoline, hexane, isopropanol, maleic anhydride, methyl methacrylate monomer, n-butyl acetate, n-propanol, n-propyl acetate, paraformaldehyde, propane, propylene oxide, p-xylene, toluene, vinyl acetate, and vinyl chloride. The maximum quantity of all chemicals identified carried in a single rail car is 132,000 pounds as provided in RG 1.91.

An analysis for the identified chemicals is conducted using the TNT mass equivalency methodologies as described in Subsection 2.2.3.1.1. The results indicate that the safe distances are less than the minimum separation distances from the VCS Unit 1 Fuel Building to the Union Pacific Railway for all of the identified chemicals (Table 2.2-210). Propane results in the largest safe distance, 4918 feet, which is less than the distance of 20,547 feet to the nearest safety-related structure for VCS Units 1 and 2. Therefore, an explosion from hazardous materials transported along the Union Pacific Railway will not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.1.2 **Flammable Vapor Clouds (Delayed Ignition)**

Flammable materials in the liquid or gaseous state can form unconfined vapor clouds that can drift towards the plant, dispersing before an ignition event as they travel downwind. The portion of the cloud with a chemical concentration within the flammable range (i.e., between the LFL and UFL) may burn if the cloud encounters an ignition source. The speed at which the flame front moves through the cloud determines whether it is considered a deflagration or a detonation. If the cloud burns quickly enough to create a detonation, an explosive force is generated.

The hazardous materials located onsite at VCS—as well as those potentially transported by pipeline, via the Victoria Barge Canal (Table 2.2-207), via U.S. Highway 77 (Table 2.2-208), and by the Union Pacific Railway (Table 2.2-209)—are evaluated to ascertain those that have the potential to form flammable and/or explosive vapor clouds. For those chemicals with an identified flammability range, the Areal Locations of Hazardous Atmospheres (ALOHA), Version 5.4.1, air dispersion model is used to determine the distances that the vapor cloud could exist in the flammability range and subsequently present the possibility of ignition (Reference 2.2-239).

The identified chemicals are evaluated to determine the possible effects of a flammable vapor cloud explosion. ALOHA is used to model the worst-case accidental vapor cloud explosion for the identified chemicals, including the safe distances and overpressure effects at the nearest safety-related structure. To model the worst-case scenario in ALOHA, detonation is chosen as the ignition source. The safe distance is measured as the distance from the spill site to the location where the pressure wave is at 1 psi overpressure. Conservative assumptions are used in the ALOHA analyses for both meteorological inputs and identified scenarios. The following meteorological assumptions are used as inputs to the computer model: ambient temperature of 25 degrees Centigrade; relative humidity of 50%; cloud cover of 50%; and atmospheric pressure of 1 atmosphere (Reference 2.2-240). For each chemical analyzed, several ALOHA runs are made to determine the worst case combination of stability class and wind speed. For each of the identified chemicals in the liquid state, it is conservatively assumed that the entire contents of the vessel leaks, forming a 1 centimeter-thick puddle where accommodated by the model. This provides a significant surface area from which to maximize evaporation and formation of a vapor cloud. For each of the identified chemicals in the gaseous state, it is assumed that the entire contents of the vessel are released over a 10-minute period into the atmosphere as a continuous direct source (Reference 2.2-241). The effects of flammable vapor clouds and vapor cloud explosions from internal and external sources are summarized in Table 2.2-211 and are described in the following subsections relative to the release source.

2.2.3.1.2.1 Onsite Chemicals

An analysis for the onsite chemicals conducted using the methodologies as described in Subsection 2.2.3.1.2 has been previously conducted in the R-COLA. The results of the R-COLA are assumed to apply to VCS Units 1 and 2 because the chemicals will be stored in similar locations and quantities. These results indicate that the safe distances are less than the minimum separation distances from the nearest safety-related structure to the onsite storage location for all chemicals with the potential to form a flammable and/or explosive vapor cloud. In addition to the chemicals analyzed in the R-COLA, a 25% sodium bisulfite solution will be used onsite at VCS. However, the sodium bisulfite solution does not present a flammability or explosive hazard (Reference 2.2-251). Therefore, a flammable vapor cloud with the possibility of ignition or explosion from hazardous materials stored onsite will not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.1.2.2 Pipelines

Transcontinental Gas Pipeline Corporation operates a natural gas transmission pipeline within the vicinity of VCS. At its closest distance, this pipeline passes within approximately 963 feet of the nearest safety-related structure for VCS Units 1 and 2, i.e., the Unit 1 control room. As described in Subsection 2.2.3.1.1.2, the nearest Transcontinental Gas Pipeline Corporation natural gas transmission pipeline also represents the bounding design-basis case for flammable vapor clouds and vapor cloud explosions. To conservatively evaluate the consequences from a potential flammable vapor cloud or vapor cloud explosion from a natural gas transmission pipeline, a worst-case scenario is considered involving the release of natural gas directly into the atmosphere, resulting in a vapor cloud. It is conservatively assumed that the initial puff, consisting of the gas from an instantaneous release, remains at ground level and contributes to the flammable and explosive cloud. The remainder of gas exiting the pipeline is assumed to rise quickly (as the result of the low density of natural gas) and not have any effect on the cloud concentration.

As the modeled vapor cloud travels toward VCS Units 1 and 2, it is plausible that the cloud concentration could become flammable along its path and a detonation could occur. The results indicate that under this scenario, the flammable vapor cloud does not exist at distances beyond 853 feet downwind (distance to LFL) from the pipe break. An explosion was conservatively assumed to take place at the leading edge of the flammable cloud resulting in a peak incident pressure of 1 psi at a distance of 1775 feet from the pipe break (Table 2.2-211). Therefore, the safe distance for the vapor cloud explosion is 1775 feet. This distance is greater than the distance from the pipeline to the nearest safety-related structure for VCS Units 1 and 2. The ensuing explosion produces a peak incident pressure of 5 psi at a distance of 1150 feet from the pipe break.

This distance is also greater than the distance from the pipeline to the nearest safety-related structure for VCS Units 1 and 2.

Methane, the main constituent of natural gas, is generally considered to be of low reactivity. No unconfined vapor cloud explosion has ever occurred following a release of either pipeline natural gas or liquefied natural gas (Reference 2.2-242). Experiments conducted in Germany (Reference 2.2-243) have indicated that mixtures of methane with air appear to be non-detonable. It was not possible to initiate detonations in methane-air mixtures, even with 2.5 kg of explosive. No events resembling detonation were observed when igniting the mixture with flames, exploding wires, and pyrotechnical ignition fuses. Large-scale experiments (Reference 2.2-242) conducted in the United Kingdom have shown that under unconfined conditions, only low-speed propagating flames are produced with no evidence of significant flame acceleration. The overpressure generated from these experiments was minimal. However, these experiments also showed that natural gas with high methane content could produce moderate overpressure if released into process arrays of extremely close packed obstacles. Based on the above, an outdoor unconfined natural gas vapor cloud explosion is considered an unlikely event.

However, to be conservative, based on the potential effects of a vapor cloud explosion and heat flux on structures positioned above the pipeline, this pipeline and any other pipeline that may produce such effects will be rerouted such that a safe distance from VCS is achieved.

2.2.3.1.2.3 Waterway Traffic

The nearest safety-related structure for VCS Units 1 and 2, i.e., the Unit 2 control room, is located approximately 26,664 feet from the Victoria Barge Canal. The hazardous materials transported on the Victoria Barge Canal identified for further analysis with regard to forming a flammable vapor cloud capable of delayed ignition following an accidental release are: acetone, acetone cyanohydrin, acrylonitrile, butadiene, cyclohexane, cyclohexanone, gasoline, and propylene.

The conservative methodology presented in Subsection 2.2.3.1.2 is used to determine the distance the formed vapor cloud could travel before ignition (the LFL boundary) using the ALOHA dispersion model. The maximum quantity of all chemicals assumed to be spilled on the waterway was 10 million pounds as provided in RG 1.91. For these cases, the maximum surface area of the spill that ALOHA would accommodate—31,400 square meters—is used. The results indicate that any vapor cloud that can form and mix sufficiently under stable atmospheric conditions will be below the LFL boundary before reaching the nearest safety-related structure for VCS Units 1 and 2. The propylene vapor cloud results in the largest traveled distance prior to reaching the LFL boundary. The distance to the LFL boundary for propylene is 4545 feet, which is less than the distance of 26,664 feet to the Unit 2 control room (Table 2.2-211).

Because each of the identified chemicals has the potential to explode, a vapor cloud explosion analysis was also performed as described in Subsection 2.2.3.1.2. Safe distances are defined as the minimum distances, with drift taken into consideration, required for an explosion to have less than a 1 psi peak incident pressure. Results for the vapor cloud explosion analysis indicate that the safe distances are less than the shortest distance to the nearest safety-related structure for VCS Units 1 and 2 for all identified chemicals (Table 2.2-211). Propylene results in the largest safe distance, 8976 feet to 1 psi, which is less than the distance of 26,664 feet to the nearest safety-related structure for VCS Units 1 and 2. Therefore, a flammable vapor cloud with the possibility of ignition or explosion from a transported hazardous material on the Victoria Barge Canal will not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.1.2.4 Highways

The nearest safety-related structure, the VCS Unit 1 reactor building, is located approximately 4076 feet from U.S. Highway 77 at its closest point of approach. The hazardous materials potentially transported on U.S. Highway 77 and identified for further analysis with regard to the potential for forming a flammable vapor cloud capable of delayed ignition following an accidental release are: acetylene, gasoline, hydrogen sulfide, methanol, methyl cyanide, natural gas, and propane. With the exception of acetylene, the maximum quantity of the identified chemicals potentially transported on the roadway is 50,000 pounds as provided in RG 1.91. Acetylene is transported in cylinders (References 2.2-237 and 2.2-238). It was conservatively assumed that 8 cubic meters of acetylene at 250 psig is equivalent to 144 cubic meters at atmospheric pressure.

The methodology presented in Subsection 2.2.3.1.2 is used for determining the distance from the accidental release site where the vapor cloud is within the flammability limits.The results indicate that any vapor cloud that forms and mixes sufficiently under stable atmospheric conditions has a concentration less than the LFL before reaching the VCS Unit 1 reactor building for all chemicals evaluated (Table 2.2-211). Propane results in the largest safe distance, 1317 feet to the LFL, which is less than the distance of 4076 feet to the nearest safety-related structure for VCS Units 1 and 2.

The chemicals identified above are also evaluated using the methodology presented in Subsection 2.2.3.1.2 to determine the effects of a possible vapor cloud explosion. The safe distance, the minimum separation distance required for an explosion to have less than a 1 psi peak incident pressure impact from the vapor cloud, is less than the shortest distance to the VCS Unit 1 reactor building to any point on U.S. Highway 77 for all chemicals evaluated (Table 2.2-211). Propane results in the largest safe distance, 3129 feet to 1 psi, which is less than the distance of 4076 feet to the nearest safety related structure for VCS Units 1 and 2. Therefore, a flammable vapor cloud ignition or explosion from hazardous materials transported on U.S. Highway 77 will not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.1.2.5 Railroad

The nearest safety-related structure, the VCS Unit 1 Fuel Building, is located approximately 20,547 feet, at its closest point of approach, from the Union Pacific Railway. The hazardous materials potentially transported on the railway that are identified for further analysis with regard to the potential for forming a flammable vapor cloud capable of delayed ignition following an accidental release are: 1,1-difluoroethane, acetaldehyde, acetone, benzene, butyraldehyde, carbon bisulphide, gasoline, hexane, isopropanol, methyl methacrylate monomer, n-butyl acetate, n-propanol, n-propyl acetate, propane, propylene oxide, p-xylene, toluene, vinyl acetate, and vinyl chloride. The maximum quantity of the identified chemicals potentially transported on the railway is 132,000 pounds as provided in RG 1.91.

The methodology presented in Subsection 2.2.3.1.2 is used to determine the distance from the accidental release site where the vapor cloud is within the flammability limits. The results indicate that any vapor cloud that forms and mixes sufficiently under stable atmospheric conditions has a concentration less than the LFL before reaching the VCS Unit 1 Fuel Building for all chemicals evaluated (Table 2.2-211). Propane results in the largest safe distance, 1881 feet to the LFL, which is less than the distance of 20,547 feet to the nearest safety-related structure for VCS Units 1 and 2.

The chemicals identified above are also evaluated using the methodology presented in Subsection 2.2.3.1.2 to determine the effects of a possible vapor cloud explosion. The safe distance, the minimum separation distance required for an explosion to have less than a 1 psi peak incident pressure impact from the vapor cloud, is less than the shortest distance to the VCS Unit 1 Fuel Building to any point on the Union Pacific Railway for all chemicals evaluated (Table 2.2-211). Propane results in the largest safe distance, 4347 feet to 1 psi, which is less than the distance of 20,547 feet to the nearest safety-related structure for VCS Units 1 and 2. Therefore, a flammable vapor cloud ignition or explosion from hazardous materials transported on the Union Pacific Railway would not adversely affect the safe operation or shutdown of VCS Units 1 and 2.}

2.2.3.1.3 **Toxic Chemicals**

Accidents involving the release of toxic chemicals from onsite storage facilities and nearby mobile sources are considered. Toxic chemicals known to be present onsite or in the vicinity of VCS, or to be frequently transported in the vicinity are evaluated. RG 1.78 requires evaluation of control room habitability following a postulated external release of hazardous chemicals from mobile or stationary sources, onsite or offsite.

The hazardous materials located onsite at VCS—as well as those potentially transported by pipeline, via the Victoria Barge Canal (Table 2.2-207), via U.S. Highway 77 (Table 2.2-208), and by the Union Pacific Railway (Table 2.2-209)—are evaluated to ascertain those that should be analyzed with respect to their potential to form a toxic vapor cloud following an accidental release. The ALOHA air dispersion model is used to predict the concentrations of toxic chemical clouds as they disperse downwind for all release scenarios with the exception of the pipeline release. The maximum distance a cloud can travel before it disperses enough to fall below the Immediately Dangerous to Life and Health (IDLH) concentration in the vapor cloud is determined using the ALOHA dispersion model. The ALOHA model is also used to predict the concentration of the chemical in the control room following a chemical release to ensure that, under worst-case scenarios, the control room operators will have sufficient time to take appropriate action.

The IDLH concentration is defined by the National Institute of Occupational Safety and Health as a situation that poses a threat of exposure that is likely to cause death or immediate or delayed permanent adverse health effects, or one that could prevent escape from such an environment. The IDLH concentrations determined by the National Institute of Occupational Safety and Health are established such that workers are able to escape such environments without suffering permanent health damage (Reference 2.2-244). Where an IDLH concentration is unavailable for a toxic chemical, the time-weighted average (TWA) or threshold limit value (TLV), promulgated by the Occupational Safety and Health Administration or adopted by the American Conference of Governmental Hygienists or the Temporary Emergency Exposure Limit, adopted by the U.S. Department of Energy, are used as the toxicity concentration level. Conservative meteorological assumptions are used: ambient temperature of 25 degrees Centigrade; relative humidity of 50%; cloud cover of 50%; and atmospheric pressure of 1 atmosphere (Reference 2.2-240). It is further assumed that the toxic vapor cloud travels downwind directly toward the control room. Several ALOHA runs are made for each chemical to determine the worst case combination of wind speed and stability class.

For each of the identified chemicals, it is conservatively assumed that the entire contents of the vessel leaks, forming a 1-centimeter-thick puddle, where accommodated by the model. For those identified hazardous materials in the gaseous state, it is conservatively assumed that the entire contents of the vessel are released over a 10-minute period into the atmosphere as a continuous direct source (Reference 2.2-241). The effects of toxic chemical releases from internal and external sources are summarized in Table 2.2-212 and are described in the following subsections relative to the release sources.

2.2.3.1.3.1 Onsite Chemicals

An analysis for the onsite chemicals conducted using the methodologies as described in Subsection 2.2.3.1.3 has been previously conducted in the R-COLA. The results of the R-COLA are assumed to apply to VCS Units 1 and 2 because the chemicals will be stored in similar locations and quantities. These results indicate that the safe distances are less than the minimum separation distances from the nearest control room to the onsite storage location for all toxic chemicals. In addition to the chemicals analyzed in the R-COLA, a 25% sodium bisulfate solution will be used onsite at VCS. However, the sodium sulite solution does not present a toxic vapor cloud hazard (References 2.2-250 and 2.2-251). Therefore, the formation of a toxic vapor cloud following an accidental release of the hazardous materials stored onsite will not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.1.3.2 Pipelines

Transcontinental Gas Pipeline Corporation operates a natural gas transmission pipeline within the vicinity of VCS. At its closest distance, this pipeline passes within approximately 963 feet of the nearest safety-related structure for VCS Units 1 and 2, i.e., the Unit 1 control room. Natural gas is not considered toxic and there is no IDLH concentration or other toxicity limit identified for this chemical. Therefore, natural gas is analyzed as an asphyxiant with regard to the potential of forming a toxic vapor cloud following an accidental release. For asphyxiants, the toxicity limit is assumed to be the chemical concentration that results in reducing the oxygen concentration to 15% or less. At 10–15% oxygen concentration, a person’s judgment and coordination are impaired (Reference 2.2-245). This threshold is equivalent to a chemical concentration of 285,700 parts per million (ppm). A natural gas concentration capable of producing an asphyxiating environment does not exist at a distance beyond 492 feet from the pipe break, which is less than the 963 feet to the Unit 1 control room. The results indicate that the formation of a toxic (asphyxiating) vapor cloud following an accidental release from a rupture in the Transcontinental Gas Pipeline Corporation natural gas transmission pipeline will not affect the control room operators and therefore would not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.1.3.3 Waterway Traffic

The nearest control room for VCS Units 1 and 2, i.e., the Unit 2 control room, is located approximately 26,664 feet from Victoria Barge Canal, a navigable waterway. The hazardous materials transported on the Victoria Barge Canal identified for further analysis with regard to forming a toxic vapor cloud following an accidental release are: acetone cyanohydrin, acrylonitrile, anhydrous ammonia, cyclohexanone, and gasoline.

The conservative methodology outlined in Subsection 2.2.3.1.3 is used to determine the concentration of a toxic chemical cloud as it disperses downwind toward the control room using the ALOHA dispersion model.

The maximum quantity of all chemicals assumed to be spilled on the waterway is 10 million pounds as provided in RG 1.91. For these cases, the maximum surface area of the spill that ALOHA would accommodate, i.e., 31,400 square meters, is used. ALOHA does not report values after 1 hour because it assumes that weather conditions or other release circumstances are likely to change after an hour. Because of the distance between the Victoria Barge Canal and the Unit 2 control room, the vapor cloud will not reach the control room within the 1-hour reporting period imposed by ALOHA under worst-case meteorological conditions. Although it is possible to determine the maximum concentrations outside of the control room, the concentrations inside the control room are not available. The concentrations of the identified hazardous materials never reach the IDLH concentration or other established toxicity limits outside of the Unit 2 control room (Table 2.2-212).

The greatest distance to an IDLH concentration for the selected hazardous materials is anhydrous ammonia, for which the concentration in the air disperses to a level below the IDLH concentration 24,816 feet from the spill site. This is less than the 26,664 feet separating the Victoria Barge Canal and the Unit 2 control room. Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials transported on the Victoria Barge Canal will not affect the control room operators and therefore would not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.1.3.4 Highways

The nearest control room for VCS, the Unit 1 control room, is located approximately 4245 feet at its closest distance to U.S. Highway 77. The hazardous materials potentially transported on U.S. Highway 77 that are identified for further analysis with regard to the potential of forming a toxic vapor cloud following an accidental release and able to travel to the control room are: ammonia, chlorine, gasoline, hydrogen chloride, hydrogen fluoride, hydrogen sulfide, methyl cyanide, Solvit SF8101, and sulfur dioxide. The maximum quantity of the identified chemicals potentially transported on the roadway is 50,000 pounds as provided in RG 1.91.

The methodology presented in Subsection 2.2.3.1.3 is used to determine the distance from the release site to the point where the toxic vapor cloud reaches the IDLH concentration boundary. The maximum concentration of each chemical attained in the control room during the first hour of the release is determined. For each scenario, it is conservatively estimated that the transport vehicle lost the entire contents.

VCS COL 6.4-2-A The results of the toxic vapor cloud analysis indicate that the following chemicals may pose toxic hazards to the Unit 1 control room: chlorine, hydrogen chloride, hydrogen fluoride, hydrogen sulfide, and sulfur dioxide. These chemicals produce indoor concentrations that are above their respective IDLH concentrations (Table 2.2-212).

For all chemicals other than those listed above, the vapor clouds that form following an accidental release on U.S. Highway 77 and travel toward the control room will not achieve an airborne concentration greater than the IDLH concentration in the Unit 1 control room (Table 2.2-212).

For those chemicals shown to exceed the IDLH concentration inside the control room, HABIT 1.1 was used to determine if sufficient time is available for control room operators to identify the potential hazard and take protective measures such as donning protective equipment. RG 1.78 states that provisions should be made such that a control room operator can take protective measures within 2 minutes after detection of a chemical release. ALOHA is a more conservative model; however, it will not provide tabulated data to show concentration change over time. The use of HABIT for assessing control room habitability is recommended in RG 1.78. It provides data showing the variation of concentration over time both inside and outside of the control room. This data was used to determine the amount of time between detection of a chemical using the toxic gas monitors described in Subsection 6.4.5 and when the IDLH concentration is reached.

HABIT used chemical release and meteorological conditions identical to those used in the ALOHA analysis. Toxic gas monitor setpoint concentrations were selected at 20% of the upper limit of the detection range but not lower than 5 ppm to avoid false alarms, and a conservative detector response time was selected. Detector setpoints and response times for the chemicals of concern are provided in Table 2.2-213. The results show that the time between when the detector alarm signals (the time to reach the detector set point at the air intake in addition to the detector response time) and when the IDLH concentration is reached inside the control room exceeds 17 minutes for all chemicals analyzed (Table 2.2-213). These results are conservative because no isolation of the control room air intakes is assumed following receipt of a toxic gas alarm.}

These results indicate that there is sufficient time for the control room operators to take protective actions after the chemical has been detected. A procedure will be written and operator training will be conducted to ensure appropriate operator response. Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials transported on U.S. Highway 77 will not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

VCS COL 2.0-6-A

2.2.3.1.3.5 Railroad

The nearest control room, the VCS Unit 1 control room, is approximately 20,645 feet from the Union Pacific Railway at its closest point of approach. The hazardous materials potentially transported on the railway identified for further analysis with regard to the potential for forming a toxic vapor cloud following an accidental release are: chlorine, hydrogen chloride, and hydrogen fluoride. The maximum quantity of the identified chemicals potentially transported on the railway is 132,000 pounds as provided in RG 1.91.

The methodology presented in Subsection 2.2.3.1.3 is used for determining the distance from the release site to the point where the toxic vapor cloud reaches the IDLH concentration boundary. The maximum concentration of each chemical attained at the control room during the release was determined. For each scenario, it is conservatively estimated that the transport vehicle loses the entire contents. ALOHA does not report values after 1 hour because it assumes that weather conditions or other release circumstances are likely to change after an hour. Because of the distance between the railway and the Unit 1 control room, under worst-case meteorological conditions, the vapor cloud takes longer than 1 hour to reach the control room. A separate function in ALOHA allows the user to obtain maximum outdoor concentrations beyond the normal 1 hour time limit. Therefore, maximum chemical concentrations at the control room air intake were used to determine if the toxic vapor cloud poses a threat to the Unit 1 control room.

Results of the toxic vapor cloud analysis indicate that all three chemicals analyzed (chlorine, hydrogen chloride, and hydrogen fluoride) may pose toxic hazards to the Unit 1 control room. These chemicals produce concentrations outside of the Unit 1 control room that are above their respective IDLH concentrations (Table 2.2-212). Therefore, it is expected that the IDLH concentration will also be exceeded inside the control room.

For those chemicals shown to exceed the IDLH concentration inside the control room, HABIT 1.1 was used to determine if sufficient time is available for control room operators to identify the potential hazard and take protective measures such as donning protective equipment. The methodology described in Subsection 2.2.3.1.3.4 was used to make this determination. Detector setpoints and response times for the chemicals of concern are provided in Table 2.2-213. The results show that the time between when the detector alarm signals (the time to reach the detector setpoint at the air intake in addition to the detector response time) and when the IDLH concentration is reached inside the control room exceeds 5 minutes for all chemicals analyzed (Table 2.2-213). These results are conservative because no isolation of the control room air intakes is assumed following receipt of a toxic gas alarm.

These results indicate that there is sufficient time for the control room operators to take protective actions after the chemical has been detected.} Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials transported on the railway will not adversely affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.1.4 Aircraft Crashes

RG 1.206 and NUREG-0800 state that the risks as the result of aircraft hazards should be sufficiently low. Further, aircraft accidents that could lead to radiological consequences in excess of the exposure guidelines of 10 CFR 50.34(a)(1) with a probability of occurrence greater than an order of magnitude of 10^{-7} per year should be considered in the design of the plant. Section 3.5.1.6 of NUREG-0800 provides three acceptance criteria for the probability of aircraft accidents to be less than 10^{-7} per year: (1) meeting plant-to-airport distance and projected annual operations criteria, (2) plant is a least 5 miles from military training routes, and (3) plant is at least 2 statute miles beyond the nearest edge of a federal airway. VCS fails to meet Item 2 of the NUREG-0800 acceptance criteria; therefore, further analysis is provided below.

2.2.3.1.4.1 Airports

As provided in NUREG-0800 the probability of an aircraft accident is considered to be less than an order of magnitude of 10^{-7} per year if the number of operations is less than a plant-to-airport distance squared times 500. Taking into consideration the airport's size, condition, and distance from the plant it can be assumed that the number of operations at Green Lake Ranch Airport are less than 50,000 (i.e. $500(10)^2$), thus meeting the criteria of NUREG-0800.

For distances greater than 10 miles from the plant site, NUREG-0800 provides that the probability of an aircraft accident is considered to be less than an order of magnitude of 10^{-7} per year if the number of operations is less than a plant-to-airport distance squared times 1000. Based on an average of 111 aircraft operations per day, it is shown that the number of operations at Victoria Regional Airport are less than 313,290 (i.e., $1000(17.7)^2$), thus meeting the criteria of NUREG-0800.

2.2.3.1.4.2 Airways

Because of the proximity of the Kingsville MOA to VCS, an analysis is conducted to determine the probability of aircraft accidents that could possibly result in radiological consequences for VCS. The probability per year of an aircraft crashing into the plant is estimated following Department of Energy (DOE) Standard DOE-STD-3014-96 (Reference 2.2-246). Flights occurring in the Kingsville MOA are treated as non-airport or in-flight phase operations.

The analysis provides an estimate of the total impact frequency per year into the facility of 9.8×10^{-8}. This meets the NUREG-0800 criteria of 10^{-7}.

2.2.3.1.5 Fires

Accidents are considered in the vicinity of VCS that could lead to high heat fluxes or smoke and nonflammable gas or chemical-bearing clouds from the release of materials as a consequence of fires. Fires from pipelines; brush and forest fires; and fires from transportation accidents are evaluated as events that could lead to high heat fluxes or to the formation of such clouds.

The Transcontinental Gas Pipeline Corporation natural gas transmission pipeline, and those chemicals transported by roadway on U.S. Highway 77, by rail on the Union Pacific Railway, and by waterway on the Victoria Barge Canal, are evaluated in Subsection 2.2.3.1.2 for potential effects of accidental releases leading to a delayed ignition and/or explosion of any formed vapor cloud. For each of the stored or transported hazardous materials evaluated, the results indicate that any formed vapor cloud will dissipate below the LFL before reaching the nearest safety-related structure. Therefore, it is not expected that there would be any hazardous effects to VCS Units 1 and 2 from fires or heat fluxes associated with transportation routes. Further, a heat flux analysis for a pipeline break and ensuing deflagration indicates that there would be no effect on the safe operation and shutdown of VCS Units 1 and 2.

Further, the potential for brush, forest, or woodland fires is evaluated. The Texas Parks and Wildlife Department has categorized the vegetation in the VCS site vicinity from a compilation of satellite imagery, land surveys, and site inspections. There are no forested areas in the site vicinity. Grasslands, marshes and croplands are the predominant vegetation types in the area (Reference 2.2-247). The area to the north of VCS Units 1 and 2 comprises the switchyard and the area to the south of VCS Units 1 and 2 comprises the cooling basin. There are no appreciable brush or trees surrounding the power block area. Therefore, the zone surrounding VCS Units 1 and 2 is of sufficient size to afford protection in the event of a fire. For perspective, the Texas Department of Public Safety recommends that a safety zone of only 30 to 50 feet be maintained around structures for protection against wildfires, whereas California has adopted regulations requiring a fire break of at least 30 feet and a fuel break to 100 feet (References 2.2-248 and 2.2-249). The safety zone around VCS Units 1 and 2 exceeds these recommended distances. Therefore, it is not expected that there will be any hazardous effects to VCS Units 1 and 2 from fires or heat fluxes associated with wild fires or fires along nearby transportation routes.

2.2.3.1.6 **Collisions with Intake Structure**

Because the raw water makeup system intake structure for VCS is not located on a navigable waterway, an evaluation that considers the probability and potential effects of impact on the plant cooling water intake structure and enclosed pumps is not necessary.

2.2.3.1.7 **Liquid Spills**

The accidental release of oil or liquids that may be corrosive, cryogenic, or coagulant are considered to determine if the potential exists for such liquids to be drawn into the plant's raw water makeup system's intake structure and circulating water system or otherwise affect the plant's safe operation. In the unlikely event that these liquids would spill into the Guadalupe River or the GBRA Calhoun Canal System, not only would they be diluted by the large quantity of river water, but the raw water makeup intake from the Calhoun Canal System is not necessary for the safe shutdown of the plant. Therefore, any spill in the Guadalupe River or the GBRA Calhoun Canal System will not affect the safe operation or shutdown of VCS Units 1 and 2.

2.2.3.2 **Effects of Design-Basis Events**

As concluded in the previous subsections, three events are identified that have a probability of occurrence of greater than 1.0×10^{-7} per year, or potential consequences that could affect the safety of the plant to the extent that the guidelines in 10 CFR Part 100 could be exceeded. These events involve the release of toxic materials along U.S. Highway 77 and the Union Pacific Railway, as well as the exceedance of 1 psi overpressure at the control room as a result of a vapor cloud explosion from Transcontinental's natural gas pipeline. As described in Subsection 6.4.5, features of the plant design provide the capability for detection of releases, manual isolation of the control room, making the control room sufficiently leak tight, and provision of protective equipment for the control room operators. These features would serve to mitigate the effects of a release of toxic materials. Further, as described in Subsection 2.2.3.1.2.4, the natural gas pipeline will be rerouted a sufficient distance to preclude it from being a potential hazard to VCS.

There are no other accidents associated with nearby industrial, transportation, or military facilities that are considered design-basis events.

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Table 2.2-201
Description of Facilities—Products and Materials

Facility	Concise Description	Primary Function	Number of Employees	Major Products
Air Liquide America Corporation	Gas separation unit	Producers of pure gas products	7	Oxygen, nitrogen, argon
INVISTA-DuPont	Manufacturer of textile intermediates Ethylene copolymers facility	Producer of nylon intermediates Producer of low-density polyethylene (LDPE) resins	555 90	Hexamethylenediamine, adipic acid, dodecanedioic acid LDPE resins
Equistar Chemicals	Manufacturer of high-density polyethylene (HDPE) resins	Producer of HDPE resins	84	HDPE resins
ConAgra International Fertilizer	Produces fertilizers for agricultural use	Producer of liquid fertilizers	4	Liquid ammonium fertilizers
Inergy Propane, LLC	Propane distributor	Distributes propane to residential, agriculture, and industry	0	Propane
Tennessee Gas Pipeline—Station 9	Natural gas compressor station	Natural gas transmission	7	Natural gas

Source: References 2.2-201, 2.2-216, 2.2-218 through 2.2-223.

Table 2.2-202
Onsite Chemical Storage

Chemical	System or Location	Tank/Tote Capacity (Gallons)	Toxicity Limit IDLH[a]
93% sulfuric acid	Plant service water system	30,000	15 mg/m^3
12 trade percent sodium hypochlorite	Plant service water system	300	10 ppm as chlorine
Proprietary scale inhibitor	Plant service water system	250	Not available
25% sodium bisulfite	Plant service water system	300	None established
Non-oxidizing Biocide	Plant service water system	750	Not available
Proprietary dispersant	Plant service water system	250	Not available
Proprietary biodispersant	Plant service water system	75	Not available
12-trade-percent sodium hypochlorite	Circulating water system	31,000	10 ppm as chlorine
Proprietary scale inhibitor	Circulating water system	20,000	Not available
Proprietary bromide (sodium bromide)	Circulating water system	5000	3 ppm as bromine
12–trade-percent sodium hypochlorite	Groundwater treatment	600	10 ppm as chlorine
Proprietary scale inhibitor	Station water to demineralization system	100	Not available
Sodium bisulfite	Station water to demineralization system	350	None established
Sulfuric acid	Station water to demineralization system	2500	15 mg/m^3
Carbon dioxide	Co_2 storage area, outside turbine building	800	40,000 ppm
Hydrogen	H_2 storage area outside turbine building	18,000	Asphyxiant
Liquid Oxygen	O_2 storage area outside turbine building	9000	None established
Liquid nitrogen	N_2 storage area outside reactor building	25,000	Asphyxiant
2.2% sodium sulfite solution	Auxiliary boiler building	555	None established
Boiler deposit control (0.72% trisodium phosphate solution)	Auxiliary boiler building	555	None established
Boiler alkalinity control (0.18% disodium phosphate solution)	Auxiliary boiler building	555	None established
Urea (dry power aqua solution 40%)	Diesel generator building	12,800	None established
Diesel fuel	Diesel generator building	215,800	None established
Gasoline	Vehicle motor pool and vehicle maintenance	10,000	None established

[a]Immediately Dangerous to Life or Health (IDLH)
Source: References 2.2-250 and 2.2-251.

Table 2.2-203 (Sheet 1 of 2)
Hazardous Materials Transported Along U.S. Highway 77

Chemical	Quantity (lbs)	Toxicity Limit (IDLH)[a]
Acetylene[b]	144 m[c]	Asphyxiant
Alkyl phenols: octylphenol, nonylphenol	50,000	None established
Aluminum sulfate	50,000	None established
Ammonia	50,000	300 ppm
Argon	50,000	Asphyxiant
Calcium chloride	50,000	None established
Carbon dioxide	50,000	40,000 ppm
Chlorine	50,000	10 ppm
Crude oil	50,000	None established
Diesel fuel	50,000	None established
Diethanolamine	50,000	0.46 ppm[c]
Engine lubricants	50,000	None established
Ferrous chloride	50,000	1 mg/m^3 as iron[c]
Ferrous sulfate solution	50,000	None established
Gasoline	50,000	300 ppm[c]
Hexanols: 1-Hexanol, n-Hexanol	50,000	75 ppm[d]
Hydrofluorosilicic acid	50,000	25 ppm as fluorine
Hydrogen chloride	50,000	50 ppm
Hydrogen fluoride	50,000	30 ppm as fluorine
Hydrogen sulfide	50,000	100 ppm
Kerosene	50,000	200 mg/m^3[c]
Liquid ammonium sulfate	50,000	None established
Liquid nitrogen	50,000	Asphyxiant
Liquid oxygen	50,000	None established
Metallic acetates (cadmium acetate)	50,000	9 mg/m^3 as cd
Methanol	50,000	6000 ppm
Methyl cyanide (acetonitrile)	50,000	500 ppm
Methyl diethanolamine	50,000	None established
Molten sulfur	50,000	None established
Motor oil/used oil	50,000	None established

Table 2.2-203 (Sheet 2 of 2)
Hazardous Materials Transported Along U.S. Highway 77

Chemical	Quantity (lbs)	Toxicity Limit (IDLH)[a]
Natural gas	50,000	Asphyxiant
Sodium phosphate	50,000	None established
Propane	50,000	2100 ppm
Sodium chlorite solution	50,000	None established
Sodium hydrosulfite	50,000	None established
Solvit MPA-7747 (THPS)	50,000	None established
Solvit SF8101 (acetic acid)	50,000	50 ppm
Sulfur dioxide	50,000	100 ppm
Sulfuric acid	50,000	15 mg/m^3
Tars/asphalt	50,000	5 mg/m^3[b]
Triethylene glycol	50,000	None established

[a]Immediately Dangerous to Life or Health (IDLH)

[b]Acetylene is transported in cylinders that range in size between 4 and 8 cubic meters. Eight cubic meters of acetylene at 250 psig is equivalent to 144 cubic meters at atmospheric pressure.

[c]Threshold Limit Value/Time Weighted Average (TLV-TWA)

[d]Temporary Emergency Exposure Limit (TEEL)

Sources: References 2.2-201 through 2.2-204; 2.2-205 through 2.2-227; 2.2-237; 2.2-238; 2.2-239; 2.2-250; 2.2-251; 2.2-254; and 2.2-255.

Table 2.2-204 (Sheet 1 of 2)
Hazardous Materials Transported Along Railroad

Material	Maximum Quantity (lbs)	Toxicity Limit (IDLH)[a]
Vinyl chloride	132,000	1000 ppm
Hydrochloric acid	132,000	50 ppm
Phosphoric acid solution	132,000	1000 mg/m^3
Formaldehyde solution	132,000	20 ppm
Chlorine	132,000	10 ppm
Hydrogen Fluoride, anhydrous	132,000	30 ppm
Benzene	132,000	500 ppm
P-Xylene	132,000	900 ppm
Propylene oxide	132,000	400 ppm
Fuel oil (diesel fuel)	132,000	None established
1,1,1,2-tetrafluoroethane	132,000	Asphyxiant
1,1-difluoroethane	132,000	Asphyxiant
Potassium Hydroxide, solution	132,000	None established
Liquefied petroleum gas (propane)	132,000	2100 ppm
Acetaldehyde	132,000	2000 ppm
n-Propanol	132,000	800 ppm
Butyraldehyde	132,000	2000 ppm[b]
Molten sulfur	132,000	None established
n-Butyl acetate	132,000	1700 ppm
Hydrogen chloride	132,000	50 ppm
Methyl methacrylate monomer	132,000	1000 ppm
Sodium Hydroxide, solution	132,000	10 mg/m^3
n-Butyl Alcohol	132,000	1400 ppm
Molten phenol	132,000	250 ppm
n-Butyl acrylate	132,000	10 ppm[c]
Toluene diisocyanate	132,000	2.5 ppm
Hexane	132,000	1100 ppm
Paraformaldehyde	132,000	None established
Dichloromethane	132,000	2300 ppm
Hydrogen peroxide	132,000	75 ppm

Table 2.2-204 (Sheet 2 of 2)
Hazardous Materials Transported Along Railroad

Material	Maximum Quantity (lbs)	Toxicity Limit (IDLH)[a]
Maleic anhydride	132,000	10 mg/m^3
Sulfuric acid	132,000	15 mg/m^3
Acetone	132,000	2500 ppm
Acetic anhydride	132,000	200 ppm
Carbon bisulphide	132,000	500 ppm
Tetrachloroethylene	132,000	150 ppm
Sodium aluminate, solution	132,000	2 mg/m^3 as Al salts[c]
Isopropanol	132,000	2000 ppm
n-Propyl acetate	132,000	1700 ppm
Vinyl acetate	132,000	500 ppm[b]
n-Butylbenzene	132,000	750 ppm[b]
Gasoline	132,000	300 ppm[c]
Anhydrous ammonia	132,000	300 ppm
Glacial acetic acid	132,000	50 ppm
Carbon dioxide	132,000	40,000 ppm
Naptha—petrol	132,000	None established
Dicyclopentadiene	132,000	40 ppm[b]
Chlorodifluoromethane	132,000	7500 ppm[b]
Sodium chlorate	132,000	None established
Toluene	132,000	500 ppm
Propionic acid	132,000	350 ppm[b]
Amyl acetate	132,000	1000 ppm

[a]Immediately Dangerous to Life or Health (IDLH)
[b]Temporary Emergency Exposure Limit (TEEL)
[c]Threshold Limit Value/Time Weighted Average (TLV-TWA)
Sources: References 2.2-239, 2.2-250, and 2.2-251.

Table 2.2-205
Hazardous Materials Transported Along Victoria Barge Canal

Material	Maximum Quantity (pounds)	Toxicity Limit (IDLH)[a]
Gasoline	10,000,000	300 ppm[b]
No. 2 fuel oil	10,000,000	None established
No. 6 fuel oil	10,000,000	None established
Naptha	10,000,000	None established
Urea ammonium nitrate	10,000,000	None established
Poly-n (ammonium polyphosphate solution)	10,000,000	None established
Urea	10,000,000	None established
Ammonium nitrate	10,000,000	None established
Anhydrous ammonia	10,000,000	300 ppm
Butadiene	10,000,000	2000 ppm
Hexamethylenediamine	10,000,000	0.5 ppm[b]
Adiponitrile	10,000,000	2 ppm[b]
Ketone alcohol (cyclohexanone)	10,000,000	700 ppm
Sodium hydroxide (solution)	10,000,000	10 mg/m^3
Cyclohexane	10,000,000	1300 ppm
Acetone	10,000,000	2500 ppm
Acetone cyanohydrin	10,000,000	15 ppm[c]
Acrylonitrile	10,000,000	85 ppm
Propylene	10,000,000	500,000 ppm[c]

[a]Immediately Dangerous to Life or Health (IDLH)
[b]Threshold Limit Value/Time Weighted Average (TLV-TWA)
[c]Temporary Emergency Exposure Limit (TEEL)
Sources: References 2.2-210, 2.2-239, 2.2-250, 2.2-251, and 2.2-252.

Table 2.2-206
Pipeline Information Summary

Operator	Pipeline System/Name	Product	Pipeline Diameter (inches)	Operating Pressure	Depth of Burial	Distance Between Isolation Valves
Gulf South Pipeline Co., L.P.	Koch Gateway	Natural gas transmission	30	Not available[b]	Not available[b]	Not available[a]
Gulf South Pipeline Co. L.P.	Victoria Gathering	Natural gas gathering	4.5	Not available[b]	Not available[b]	Not available[b]
Kinder Morgan Texas Pipeline, L.P.[a]	Gulf Coast Mainline #1	Natural gas transmission	26	900 psig	45 inches	18.0 miles
Kinder Morgan Texas Pipeline, L.P.[a]	Gulf Coast Mainline #2	Natural gas transmission	30	900 psig	45 inches	18.0 miles
Kinder Morgan Texas Pipeline, L.P.[a]	Tom O'Connor, FL-Missouri City Jct.	Natural gas transmission	30	795 psig	30 inches	17.0 miles
Transcontinental Gas Pipeline Corp.	Mainline 26-0100	Natural gas transmission	26	700 psig	36 inches	17.6 miles
Tennessee Gas Pipeline Company	100-1	Natural gas transmission	24	750 psig	36 inches	10.0 miles
Tennessee Gas Pipeline Company	100-2	Natural gas transmission	24	750 psig	36 inches	10.0 miles
Tennessee Gas Pipeline Company	100-3	Natural gas transmission	30	750 psig	36 inches	10.0 miles
Tennessee Gas Pipeline Company	Coleto Creek	Natural gas transmission	12.75	Not available[b]	Not available[b]	Not available[b]
Citgo Products Pipeline Company	Casa Pipeline-Nueces St. to Victoria St.	Gasoline and diesel fuel	8–10	625 psig	30 inches	5.9 miles
Crosstex Gulf Coast Transmission, LTD	Gulf Coast Transmission	Natural gas gathering	14	Not available[b]	Not available[b]	Not available[b]
Enerfin Field Services, LLC	McFaddin & Refugio	Natural gas gathering	4.5	Not available[b]	Not available[b]	Not available[b]
Natural Gas Pipeline Company of America	South Texas Lats., Petrotex Lateral	Natural gas transmission	4.5	Not available[b]	Not available[b]	Not available[b]

Note: Information on the pipeline age and type of isolation valves was not available
[a]Natural Gas Pipeline Company of America is a subsidiary of Kinder Morgan.
[b]This information was not provided by the pipeline operators.
Source: Reference 2.2-205.

Table 2.2-207 (Sheet 1 of 2)
Disposition of Hazardous Materials Transported on Waterway

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Gasoline	300 ppm[b]	1.4–7.4%	Vapor may explode	9.18 psia	Toxicity analysis Flammability analysis Explosive analysis
No. 2 fuel oil	None established	1.3–6.0%	None listed	0.057 psi at 80°F	No further analysis required—low vapor pressure[d]
No. 6 fuel oil	None established	1.0–5.0%	None listed	0.057 psi at 80°F	No further analysis required—low vapor pressure[d]
Naptha	None established	0.7–6.0%	Vapor may explode	0.3 kPa at 20°C	No further analysis required—low vapor pressure[d]
Urea ammonium nitrate	None established	Not flammable	None listed	Not available—vaporization unlikely	No further analysis required
Poly-N (ammonium polyphospate solution)	None established	Not flammable	None listed	Not available—no inhalation hazard	No further analysis required
Urea	None established	Not flammable	None listed	Not available—solid	No further analysis required
Ammonium nitrate	None established	Not flammable	None listed	Not available—solid	No further analysis required
Anhydrous ammonia	300 ppm	15.5–27.0%[e]	Vapor may explode[(5)]	157.000 psi at 80°F	Toxicity analysis
Butadiene	2000 ppm[b]	2.0–11.5%	Vapor may explode	Compressed gas	Flammability analysis Explosive analysis
Hexamethylenediamine	0.5 ppm[b]	Flammable solid	Flammable solid	Not available—solid	Explosive analysis
Adiponitrile	2 ppm[b]	1.7–4.9%	Vapor may explode	0.3 Pa at 20°C	No further analysis required—low vapor pressure[(4)]

Table 2.2-207 (Sheet 2 of 2)
Disposition of Hazardous Materials Transported on Waterway

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Ketone alcohol (cyclohexanone)	700 ppm	1.1–9.4%	Vapor may explode	0.503 psi at 80°F	Toxicity analysis Flammability analysis Explosive analysis
Sodium hydroxide solution	10 mg/m^3	Not flammable	None listed	1 mmHg at 20°C	No further analysis required—low vapor pressure[d].
Cyclohexane	1300 ppm[a]	1.33–8.35%	Vapor may explode	1.84 psi at 77°F	Flammability analysis Explosive analysis
Acetone	2500 ppm[a]	2.6–12.8%	Vapor may explode	4.485 psi at 77°F	Flammability analysis Explosive analysis
Acetone cyanohydrin	15 ppm[c]	2.2–12.0%	Vapor may explode	0.435 kPa at 77°F	Toxicity analysis Flammability analysis Explosive analysis
Acrylonitrile	85 ppm	3.05–17.0%	Vapor may explode	2.056 psi at 77°F	Toxicity analysis Flammability analysis Explosive analysis
Propylene	500,000 ppm[a,c]	2.0–11.0%	Vapor may explode	Compressed gas	Flammability analysis Explosive analysis

[a]The allowable amount transported a specific distance from the control room, as calculated by RG 1.78, was greater than the actual amount transported at that distance thus the chemical did not pose a threat.

[b]Threshold Limit Value/Time Weighted Average (TLV-TWA)

[c]Temporary Emergency Exposure Limit (TEEL)

[d]If a chemical had a vapor pressure below 10 torr (0.193 psi) then no further analysis was required.

[e]Studies have shown that an ammonia-air mixture does not ignite at less than 1562°F. Conditions favorable for ignition are seldom encountered during normal operations due to this high ignition temperature required.

Sources: References 2.2-210, 2.2-239, 2.2-250, 2.2-251, 2.2-252, 2.2-256, 2.2-264, and 2.2-266.

Table 2.2-208 (Sheet 1 of 3)
Disposition of Hazardous Materials Transported on U.S. Highway 77

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Acetylene	**Asphyxiant[a]**	**2.5–100%**	**Vapor may explode**	**Compressed gas**	**Flammability analysis Explosive analysis**
Alkyl phenols: octylphenol, nonylphenol	**None established**	**~ 1.0% LEL**	**Vapor may explode**	**Negligible at 20°C**	**No further analysis required—low vapor pressure[e]**
Aluminum Sulfate	**None established**	**Not flammable**	**Not explosive**	**Not available—solid**	**No further analysis required**
Ammonia	**300 ppm**	**15.5–27.0%[f]**	**Vapor may explode[f]**	**157 psi at 80°F**	**Toxicity analysis**
Argon	**Asphyxiant[a]**	**Not flammable**	**Not explosive**	**Not available - gas**	**No further analysis required**
Calcium chloride	**None established**	**Not flammable**	**Not explosive**	**Not available - solid**	**No further analysis required**
Carbon dioxide	**40,000 ppm[a]**	**Not flammable**	**Not explosive**	**907.299 psi at 75°F**	**No further analysis required**
Chlorine	**10 ppm**	**Not flammable**	**Not explosive**	**70.04 psi at 50°F**	**Toxicity analysis**
Crude oil	**None established**	**Not available**	**Not available**	**0.057 psi at 80°F**	**No further analysis required—low vapor pressure[e]**
Diesel fuel	**None established**	**1.3–6.0%**	**Vapor may explode**	**0.057 psi at 80°F**	**No further analysis required—low vapor pressure[e]**
Diethanolamine	**0.46 ppm[b]**	**1.6–9.8%**	**Vapor may explode**	**< 1 Pa at 20°C**	**No further analysis required—low vapor pressure[e]**
Engine lubricants	**None established**	**Not available**	**Not available**	**0.057 psi at 80°F**	**No further analysis required—low vapor pressure[e]**
Ferrous chloride	**1 mg/m^3 as iron[b]**	**Not flammable**	**None listed**	**Not available—solid**	**No further analysis required**
Ferrous sulfate solution	**None established**	**Not flammable**	**None listed**	**Vapor is water**	**No further analysis required**
Gasoline	**300 ppm[b]**	**1.4–7.4%**	**Vapor may explode**	**9.18 psia**	**Toxicity analysis Flammability analysis Explosive analysis**
Hexanols: 1-Hexanol, n-Hexanol	**75 ppm[c]**	**1.2–7.7%**	**Vapor may explode**	**0.124 kPa at 25°C**	**No further analysis required—low vapor pressure(5)**
Hydrofluorosilicic acid	**25 ppm as fluorine**	**Not flammable**	**None listed**	**24 mmHg at 77°F**	**Decomposes into hydrogen fluoride—HF toxicity analysis is bounding**

Table 2.2-208 (Sheet 2 of 3)
Disposition of Hazardous Materials Transported on U.S. Highway 77

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Hydrogen chloride	**50 ppm as chlorine**	**Not flammable**	**None listed**	**148.299 psi at –25°F**	**Toxicity analysis**
Hydrogen fluoride	**30 ppm as fluorine**	**Not flammable**	**None listed**	**6.923 psi at 30°F**	**Toxicity analysis**
Hydrogen sulfide	**100 ppm**	**4.3–45.5%**	**Vapor may explode**	**Compressed gas**	**Toxicity analysis** **Flammability analysis** **Explosive analysis**
Kerosene	**200 mg/m^3[b]**	**0.7 – 5.0%**	**Vapor may explode**	**0.056 psi at 80°F**	**No further analysis required—low vapor pressure(5)**
Liquid ammonium sulfate	**None established**	**Not flammable**	**None listed**	**Not available**	**No further analysis required**
Liquid nitrogen	**Asphyxiant[a]**	**Not flammable**	**None listed**	**14.41 psi at –320°F**	**No further analysis required**
Liquid oxygen	**None established**	**Not flammable**	**None listed**	**36.26 psi at –280°F**	**No further analysis required**
Metallic acetates	**9 mg/m^3 as Cd**	**Not flammable**	**None listed**	**Not available—solid**	**No further analysis required**
Methanol	**6000 ppm[a]**	**6.0–36.5%**	**Vapor may explode**	**2.3843 psi at 77°F**	**Flammability analysis** **Explosive analysis**
Methyl cyanide (acetonitrile)	**500 ppm**	**4.4–16.0%**	**Vapor may explode**	**1.6784 psi at 77°F**	**Toxicity analysis** **Flammability analysis** **Explosive analysis**
Methyl diethanolamine	**None established**	**0.9–8.4%**	**None listed**	**0.03 Pa at 25°C**	**No further analysis required—low vapor pressure[e]**
Molten sulfur	**None established**	**Not flammable**	**None listed**	**0.003 psi at 280°F**	**No further analysis required—low vapor pressure[e]**
Motor oil/used oil	**None established**	**Not available**	**Not available**	**0.057 psi at 80°F**	**No further analysis required—low vapor pressure[e]**
Natural gas	**Asphyxiant[a]**	**4.4–16.5%**	**Vapor may explode**	**Compressed gas**	**Flammability analysis** **Explosive analysis**
Sodium phosphate	**None established**	**Not flammable**	**None listed**	**Not available—solid**	**No further analysis required**
Propane	**2100 ppm[a]**	**2.0–9.5%**	**Vapor may explode**	**Liquefied gas**	**Flammability analysis** **Explosive analysis**

Table 2.2-208 (Sheet 3 of 3)
Disposition of Hazardous Materials Transported on U.S. Highway 77

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Sodium chlorite solution	None established	Not flammable	None listed	Not available	No further analysis required
Sodium hydrosulfite	None established	Flammable solid	Combustible solid	Not available—solid	Explosive analysis
Solvit MPA-7747 (THPS)	None established	Not flammable	None listed	0.7 kPa at 25°C	No further analysis required—low vapor pressure[e]
Solvit SF8101 (acetic acid)	50 ppm	4.0–19.9%[d]	Vapor may explode[d]	0.324 psi at 80°F	Toxicity analysis
Sulfur dioxide	100 ppm	Not flammable	None listed	40.97 psi at 60°F	Toxicity analysis
Sulfuric acid	15 mg/m^3	Not flammable	None listed	1 mmHg at 295°F	No further analysis required—low vapor pressure[e]
Tars/asphalt	5 mg/m^3[b]	Combustible	None listed	Negligible at 20°C	No further analysis required—low vapor pressure[e]
Triethylene glycol	None established	0.9–9.2%	Vapor may explode	0.02 Pa at @ 20°C	No further analysis required—low vapor pressure[e]

[a]The allowable amount transported a specific distance from the control room, as calculated by RG 1.78, was greater than the actual amount transported at that distance thus the chemical did not pose a threat.

[b]Threshold Limit Value/Time Weighted Average (TLV-TWA)

[c]Temporary Emergency Exposure Limit (TEEL)

[d]The concentration of the vapor above the liquid was less than the LFL for the chemical; thus, no further analysis was required.

[e]If a chemical had a vapor pressure below 10 torr (0.193 psi), no further analysis was required.

[f]Studies have shown that an ammonia-air mixture does not ignite at less than 1562°F. Conditions favorable for ignition are seldom encountered during normal operations because of the high ignition temperature required.

Sources: References 2.2-201 through 2.2-204, 2.2-224 through 2.2-226, 2.2-239, 2.2-250, 2.2-251, and 2.2-254 through 2.2-261.

Table 2.2-209 (Sheet 1 of 4)
Disposition of Hazardous Materials Transported on Railroad

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Vinyl chloride	1000 ppm[a]	3.6–33.0%	Vapor may explode	Compressed gas	Flammability analysis Explosive analysis
Hydrochloric acid	50 ppm	Not flammable	None listed	148.299 psi at –25°F as hydrogen chloride	Toxicity analysis as hydrogen chloride
Phosphoric acid solution	1000 mg/m^3	Not flammable	None listed	5.5 mmHg at 20°C	No further analysis required—low vapor pressure[e]
Formaldehyde solution	20 ppm	7.0–73.0%	Vapor may explode	0.042 psi at 80°F	No further analysis required—low vapor pressure[e]
Chlorine	10 ppm	Not flammable	None listed	74.040 psi at 50°F	Toxicity analysis
Hydrogen fluoride	30 ppm	Not flammable	None listed	6.923 psi at 30°F	Toxicity analysis
Benzene	500 ppm[a]	1.3–7.9%	Vapor may explode	1.85 psi at 77°F	Flammability analysis Explosive analysis
p-Xylene	900 ppm[a]	1.1–7.0%	Vapor may explode	0.171 psi at 77°F	Flammability analysis Explosive analysis
Propylene oxide	400 ppm[a]	2.1–38.5%	Vapor may explode	10.5 psi at 77°F	Flammability analysis Explosive analysis
Fuel oil (diesel fuel)	None established	1.3–6.0%	None listed	0.057 psi at 80°F	No further analysis required—low vapor pressure[e]
1,1,1,2-tetrafluoroethane	Asphyxiant[a]	Not flammable	None listed	630 kPa at 25°C	No further analysis required
1,1-difluoroethane	Asphyxiant[a]	3.7–18.0%	Vapor may explode	Compressed gas	Flammability analysis Explosive analysis
Potassium Hydroxide, solution	None established	Not flammable	None listed	2 mmHg at 20°C	No further analysis required—low vapor pressure[e]
Liquefied petroleum gas (propane)	2100 ppm[a]	2.1–9.5%	Vapor may explode	Liquefied gas	Flammability analysis Explosive analysis
Acetaldehyde	2000 ppm[a]	4.0–60.0%	Vapor may explode	17.5 psi at 77°F	Flammability analysis Explosive analysis

Table 2.2-209 (Sheet 2 of 4)
Disposition of Hazardous Materials Transported on Railroad

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
n-Propanol	800 ppm[a]	2.1–13.5%	Vapor may explode	0.335 psi at 77°F	Flammability analysis Explosive analysis
Butyraldehyde	2000 ppm[a,b]	2.5%–10.6%	Vapor may explode	3.40 psi at 77°F	Flammability analysis Explosive analysis
Molten sulfur	None established	Not flammable	None listed	0.003 psi at 280°F	No further analysis required—low vapor pressure[e]
n-Butyl acetate	1700 ppm[a]	1.7–7.6%	Vapor may explode	0.254 psi at 77°F	Flammability analysis Explosive analysis
Hydrogen chloride	50 ppm	Not flammable	None listed	148.299 psi at -25°F	Toxicity analysis
Methyl methacrylate monomer	1000 ppm[a]	2.1–12.5%	Vapor may explode	0.781 psi at 77°F	Flammability analysis Explosive analysis
Sodium hydroxide solution	10 mg/m^3	Not flammable	None listed	1 mmHg at 20°C	No further analysis required—low vapor pressure[e]
n-Butyl alcohol	1400 ppm[a]	1.4–11.2%	Vapor may explode	0.137 psi at 80°F	No further analysis required—low vapor pressure[e]
Molten phenol	250 ppm	1.7–8.6%	Vapor may explode	47 Pa at 20°C	No further analysis required—low vapor pressure[e]
n-Butyl acrylate	10 ppm[a,c]	1.4–9.4%	Vapor may explode	0.114 psi at 80°F	No further analysis required—low vapor pressure[e]
Toluene diisocyanate	2.5 ppm	0.9–9.5%	Vapor may explode	1.3 Pa at 20°C	No further analysis required—low vapor pressure[e]
Hexane	1100 ppm[a]	1.2–7.7%	Vapor may explode	2.94 psi at 77°F	Flammability analysis Explosive analysis
Paraformaldehyde	None established	Combustible solid	Combustible solid	Not available–solid	Explosive analysis
Dichloromethane	2300 ppm[a]	Not flammable	None listed	9.237 psi at 80°F	No further analysis required.
Hydrogen peroxide	75 ppm	Not flammable	None listed	0.143 psi at 80°F	No further analysis required—low vapor pressure[e]
Maleic anhydride	10 mg/m^3	Combustible solid	Combustible solid	Not available—solid	Explosive analysis

Table 2.2-209 (Sheet 3 of 4)
Disposition of Hazardous Materials Transported on Railroad

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Sulfuric acid	15 mg/m^3	Not flammable	None listed	1 mmHg at 295°F	No further analysis required—low vapor pressure
Acetone	2500 ppm [a]	2.6–12.8%	Vapor may explode	4.49 psi at 77°F	Flammability analysis Explosive analysis
Acetic anhydride	200 ppm	2.7–10.3%	Vapor may explode	0.119 psi at 80°F	No further analysis required —low vapor pressure[e]
Carbon bisulphide	500 ppm[a]	1.3–50.0%	Vapor may explode	6.96 psi at 77°F	Flammability analysis Explosive analysis
Tetrachloroethylene	150 ppm[a]	Not flammable	None listed	0.425 psi at 80°F	No further analysis required
Sodium aluminate, solution	2 mg/m^3 as Al salts[c]	Not flammable	None listed	Negligible at 20°C	No further analysis required—low vapor pressure[e]
Isopropanol	2000 ppm[a]	2.3–12.7%	Vapor may explode	0.871 psi at 77°F	Flammability analysis Explosive analysis
n-Propyl acetate	1700 ppm[a]	2.0–8.0%	Vapor may explode	0.642 psi at 77°F	Flammability analysis Explosive analysis
Vinyl acetate	500 ppm[a,b]	2.6–13.4%	Vapor may explode	2.26 psi at 77°F	Flammability analysis Explosive analysis
n-Butylbenzene	750 ppm[b]	0.8–5.8%	Vapor may explode	1.33hPa at 23°C	No further analysis required—low vapor pressure[e]
Gasoline	300 ppm[a,c]	1.4–7.4%	Vapor may explode	9.18 psia	Flammability analysis Explosive Analysis
Anhydrous ammonia	300 ppm[a]	15.5–27.0% [f]	Vapor may explode [f]	157.000 psi at 80°F	No further analysis required
Glacial acetic acid	50 ppm[a]	4.0–19.9% [d]	Vapor may explode[d]	0.324 psi at 80°F	No further analysis required
Carbon dioxide	40,000 ppm [a]	Not flammable	None listed	907.299 psi at 75°F	No further analysis required
Naptha—petrol	None established	0.7–6.0%	Vapor may explode	0.3 kPa at 20°C	No further analysis required—low vapor pressure[e]

Table 2.2-209 (Sheet 4 of 4)
Disposition of Hazardous Materials Transported on Railroad

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Dicyclopentadiene	**40 ppm [b]**	**0.8–6.3%**	**Vapor may explode**	**0.092 psi at 80°F**	**No further analysis required—low vapor pressure[e]**
Chlorodifluoromethane	**7500 ppm[a,b]**	**Not flammable**	**None listed**	**47.96 psi at 10°F**	**No further analysis required**
Sodium chlorate	**None established**	**Not flammable**	**None listed**	**Not available–solid**	**No further analysis required**
Toluene	**500 ppm [a]**	**1.27–7.0%**	**Vapor may explode**	**0.555 psi at 77°F**	**Flammability analysis Explosive analysis**
Propionic acid	**350 ppm [b]**	**2.9–12.1%**	**Vapor may explode**	**0.092 psi at 80°F**	**No further analysis required—low vapor pressure**
Amyl acetate	**1000 ppm**	**1.1–7.5%**	**Vapor may explode**	**0.116 psi at 80°F**	**No further analysis required—low vapor pressure[e]**

[a]The allowable amount transported a specific distance from the control room, as calculated by RG 1.78, was greater than the actual amount transported at that distance; thus, the chemical did not pose a threat.

[b]Temporary Emergency Exposure Limit (TEEL)

[c]Threshold Limit Value/Time Weighted Average (TLV-TWA)

[d]The concentration of the vapor above the liquid was less than the LFL for the chemical; thus, no further analysis was required.

[e]If a chemical had a vapor pressure below 10 torr (0.193 psi), no further analysis was required.

[f]Studies have shown that an ammonia-air mixture does not ignite at less than 1562°F. Conditions favorable for ignition are seldom encountered during normal operations because of the high ignition temperature required.

Sources: References 2.2-239, 2.2-250, 2.2-251, 2.2-256, and 2.2-262 through 2.2-266.

Table 2.2-210 (Sheet 1 of 2)
Design-Basis Events—Explosions

Source	Material Evaluated	Quantity (lbs)	Heat of Combustion (Btu/lb)	Distance to Nearest Safety Related Structure (feet)	Distance for Explosion to have less than 1 psi of Peak Incident Pressure (feet)
U.S. Highway 77	**Acetylene**	144 m^3	20,747	4076	684
	Gasoline	50,000	18,720	4076	260
	Hydrogen sulfide	50,000	6552	4076	2462
	Methanol	50,000	8419	4076	225
	Methyl cyanide	50,000	13,360	4076	218
	Natural gas	50,000	21,517	4076	3660
	Propane	50,000	19,782	4076	3559
	Sodium hydrosulfite	50,000	N/A[a]	4076	1658
Union Pacific Railway	**1,1-Difluoroethane**	132,000	7950	20,547	3630
	Acetaldehyde	132,000	10,600	20,547	443
	Acetone	132,000	12,250	20,547	305
	Benzene	132,000	17,460	20,547	316
	Butyraldehyde	132,000	15,210	20,547	330
	Carbon Bisulphide	132,000	5814	20,547	351
	Gasoline	132,000	18,720	20,547	359
	Hexane	132,000	19,246	20,547	365
	Isopropanol	132,000	12,960	20,547	316
	Maleic anhydride	132,000	N/A[a]	20,547	2291
	Methyl methacrylate monomer	132,000	11,400	20,547	336
	n-Butyl acetate	132,000	13,130	20,547	320
	n-propanol	132,000	13,130	20,547	321
	n-propyl acetate	132,000	11,255	20,547	294

Table 2.2-210 (Sheet 2 of 2)
Design-Basis Events—Explosions

Source	Material Evaluated	Quantity (lbs)	Heat of Combustion (Btu/lb)	Distance to Nearest Safety Related Structure (feet)	Distance for Explosion to have less than 1 psi of Peak Incident Pressure (feet)
Union Pacific Railway	**Paraformaldehyde**	132,000	NA[a]	20,547	2291
	Propane	132,000	19,782	20,547	4918
	Propylene oxide	132,000	13,000	20,547	443
	p-Xylene	132,000	17,559	20,547	336
	Toluene	132,000	17,430	20,547	315
	Vinyl acetate	132,000	9754	20,547	311
	Vinyl chloride	132,000	8136	20,547	3658
Victoria Barge Canal	**Acetone**	10,000,000	12,250	26,664	1293
	Acetone cyanohydrin	10,000,000	11,312	26,664	1324
	Acrylonitrile	10,000,000	14,300	26,664	1433
	Butadiene	10,000,000	19,008	26,664	20,536
	Cyclohexane	10,000,000	18,684	26,664	1467
	Cyclohexanone	10,000,000	15,430	26,664	1414
	Gasoline	10,000,000	18,720	26,664	1519
	Hexamethylenediamine	10,000,000	NA[a]	26,664	9695
	Propylene	10,000,000	19,692	26,664	20,779
Transcontinental Gas Pipeline	**Natural gas**	NA	21,517	963	NA[b]

[a]For combustible solids not intended for use as explosive, a TNT mass equivalent of 1 is used. Therefore, heat of combustion is not necessary (Reference 2.2-202).
[b]The overpressure does not reach 1 psi.

Table 2.2-211 (Sheet 1 of 2)
Design-Basis Events—Flammable Vapor Clouds (Delayed Ignition) and Vapor Cloud Explosions

Source	Material Evaluated	Quantity (lbs)	Distance to Nearest Safety Related Structure (feet)	Distance to UFL (feet)	Distance to LFL (feet)	Safe Distance for Vapor Cloud Explosions (feet)	Peak Overpressure at Nearest Safety Related Structure (psi)
U.S. Highway 77	Acetylene	144 m^3	4076	66	417	576	Not significant[a]
	Gasoline	50,000	4076	228	387	984	0.135
	Hydrogen sulfide	50,000	4076	Not exceeded	714	1773	0.322
	Methanol	50,000	4076	Not exceeded	132	348	Not significant[a]
	Methyl cyanide	50,000	4076	Not exceeded	177	546	Not significant[a]
	Natural gas	50,000	4076	252	759	2847	0.611
	Propane	50,000	4076	279	1317	3129	0.679
Union Pacific Railway	1,1-Difluoroethane	132,000	20,547	Not exceeded	903	2313	Not significant[a]
	Acetaldehyde	132,000	20,547	Not exceeded	1539	3204	Not significant[a]
	Acetone	132,000	20,547	468	969	1989	Not significant[a]
	Benzene	132,000	20,547	432	855	1806	Not significant[a]
	Butyraldehyde	132,000	20,547	420	741	1626	Not significant[a]
	Carbon bisulphide	132,000	20,547	Not exceeded	1359	2208	Not significant[a]
	Gasoline	132,000	20,547	102	162	480	Not significant[a]
	Hexane	132,000	20,547	600	1314	2811	Not significant[a]
	Isopropanol	132,000	20,547	273	486	1083	Not significant[a]
	Methyl methacrylate monomer	132,000	20,547	270	459	1008	Not significant[a]
	n-Butyl acetate	132,000	20,547	Not exceeded	132	378	Not significant[a]
	n-Propanol	132,000	20,547	Not exceeded	180	522	Not significant[a]
	n-Propyl acetate	132,000	20,547	303	462	984	Not significant[a]
	Propane	132,000	20,547	378	1881	4347	0.13

Table 2.2-211 (Sheet 2 of 2)
Design-Basis Events—Flammable Vapor Clouds (Delayed Ignition) and Vapor Cloud Explosions

Source	Material Evaluated	Quantity (lbs)	Distance to Nearest Safety Related Structure (feet)	Distance to UFL (feet)	Distance to LFL (feet)	Safe Distance for Vapor Cloud Explosions (feet)	Peak Overpressure at Nearest Safety Related Structure (psi)
Union Pacific Railway	**Propylene oxide**	132,000	20,547	291	1644	3339	Not significant[a]
	p-Xylene	132,000	20,547	Not exceeded	126	336	Not significant[a]
	Toluene	132,000	20,547	285	486	1083	Not significant[a]
	Vinyl acetate	132,000	20,547	372	699	1473	Not significant[a]
	Vinyl chloride	132,000	20,547	Not exceeded	948	2697	Not significant[a]
Victoria Barge Canal	**Acetone**	10,000,000	26,664	891	2070	4017	Not significant[a]
	Acetone cyanohydrin	10,000,000	26,664	Not exceeded	Not exceeded	No explosion occurs	NA
	Acrylonitrile	10,000,000	26,664	633	1347	2946	Not significant[a]
	Butadiene	10,000,000	26,664	573	3993	8448	0.223
	Cyclohexane	10,000,000	26,664	894	1944	3924	Not significant[a]
	Cyclohexanone	10,000,000	26,664	Not exceeded	Not exceeded	No explosion occurs	NA
	Gasoline	10,000,000	26,664	723	1326	3018	Not significant[a]
	Propylene	10,000,000	26,664	639	4545	8976	0.229
Transcontinental Gas Pipeline	**Natural gas**	NA	963	Not calculated	853	1775	>5[b]

[a] ALOHA reports overpressures of less than 0.1 psi as not significant (Reference 2.2-239).
[b] The natural gas pipeline will be rerouted a sufficient distance to preclude it from being a potential hazard to VCS.

VCS COL 6.4-2-A

Table 2.2-212
Design-Basis Events—Toxic Vapor Clouds

Source	Material Evaluated	Quantity (lbs)	Distance to Control Room (feet)	IDLH (ppm)	Distance to IDLH (feet)	Maximum Control Room Concentration (ppm)
U.S. Highway 77	**Ammonia**	50,000	4245	300	11,616	174
	Chlorine	50,000	4245	10	>31,680	425
	Gasoline	50,000	4245	300 (TLV-TWA)	1662	37.1
	Hydrogen chloride	50,000	4245	50	24,816	658
	Hydrogen fluoride	50,000	4245	30	>31,680	4150
	Hydrogen sulfide	50,000	4245	100	19,536	681
	Methyl cyanide	50,000	4245	500	1902	80.3
	Solvit SF8101 (acetic acid)	50,000	4245	50	4938	30.9[a]
	Sulfur dioxide	50,000	4245	100	15,312	457
Union Pacific Railway	**Chlorine**	132,000	20,645	10	>31,680	Not available
	Hydrogen chloride	132,000	20,645	50	>31,680	Not available
	Hydrogen fluoride	132,000	20,645	30	>31,680	Not available
Victoria Barge Canal	**Anhydrous ammonia**	10,000,000	26,664	300	24,816	133 ppm
	Cyclohexanone	10,000,000	26,664	700	480	Not available
	Acetone cyanohydrin	10,000,000	26,664	15 (TEEL)	687	0.0562
	Acrylonitrile	10,000,000	26,664	85	19,008	2.81[a]
	Gasoline	10,000,000	26,664	300 (TLV-TWA)	5808	3.09 [a]
Transcontinental Gas Pipeline	**Natural gas**	NA	963	Asphyxiant	492	NA

a. ALOHA reported that these values will increase after the first hour, but the maximum values were not available because ALOHA does not report concentrations after 1 hour (Reference 2.2-239)

VCS COL 6.4-2-A

Table 2.2-213
Design-Basis Events—Operator Response Time for Toxic Vapor Clouds

Source	Material Evaluated	Quantity (lbs)	Distance to Control Room (feet)	IDLH (ppm)	Detector Set Point (ppm)	Detector Response Time (sec)	Time to reach Detector Set Point[a]	Time to reach IDLH[b]
U.S. Highway 77	**Chlorine**	50,000	4245	10	5	60	219 sec	>1245 sec
	Hydrogen chloride	50,000	4245	50	6	100	188 sec	>1245 sec
	Hydrogen fluoride	50,000	4245	30	5	60	145 sec	>1245 sec
	Hydrogen sulfide	50,000	4245	100	10	40	218 sec	>1245 sec
	Sulfur dioxide	50,000	4245	100	5	45	211 sec	>1245 sec
Union Pacific Railway	**Chlorine**	132,000	20,645	10	5	60	27 min	>32 min
	Hydrogen chloride	132,000	20,645	50	6	100	24 min	>32 min
	Hydrogen fluoride	132,000	20,645	30	5	60	20 min	>32 min

[a]The time to reach the detector setpoint was measured at the control room air intake.
[b]The time reported is the time to reach the IDLH concentration inside the control room.

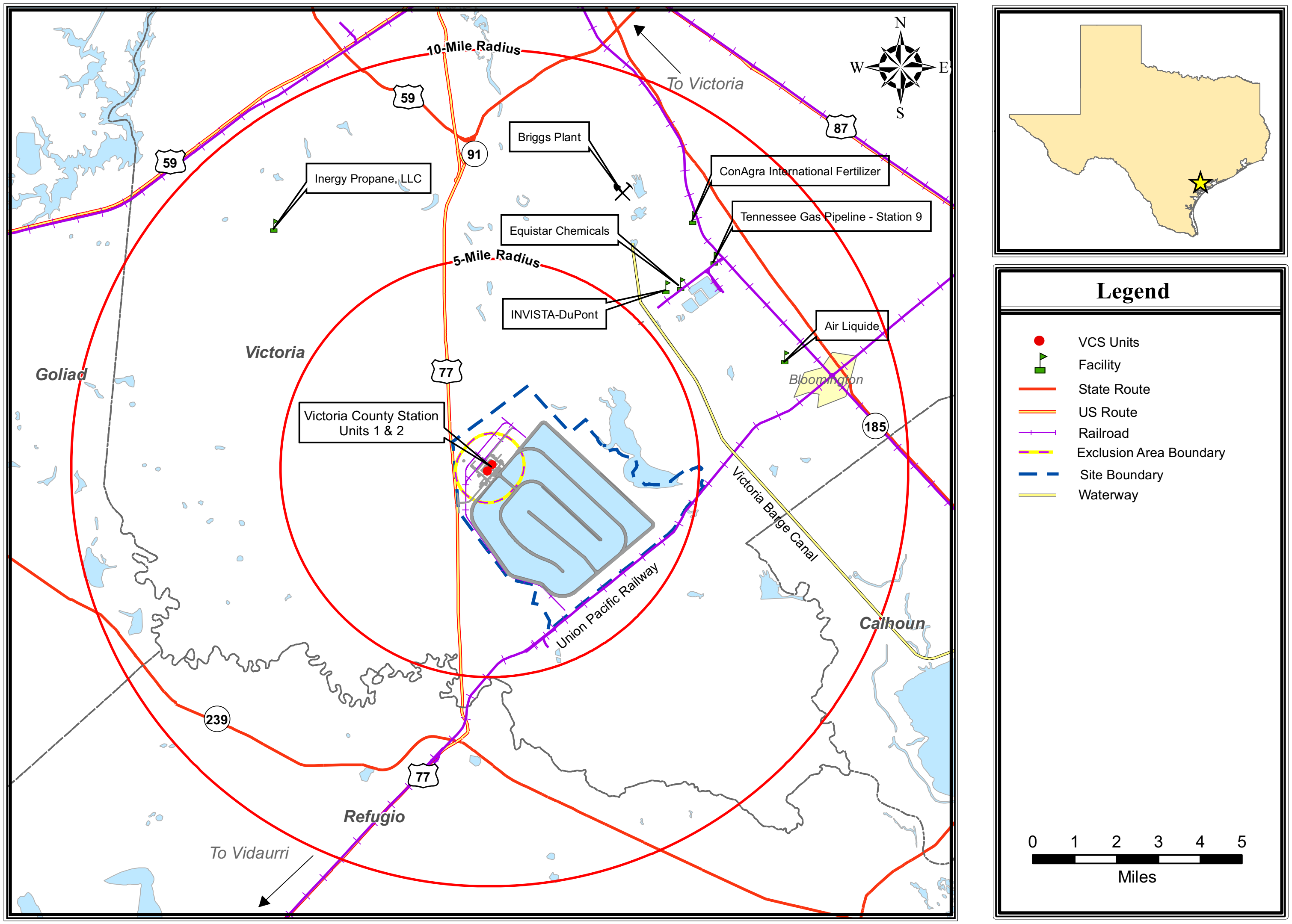

Figure 2.2-201 Transportation Routes and Industrial Facilities in the 10-mile VCS Site Vicinity

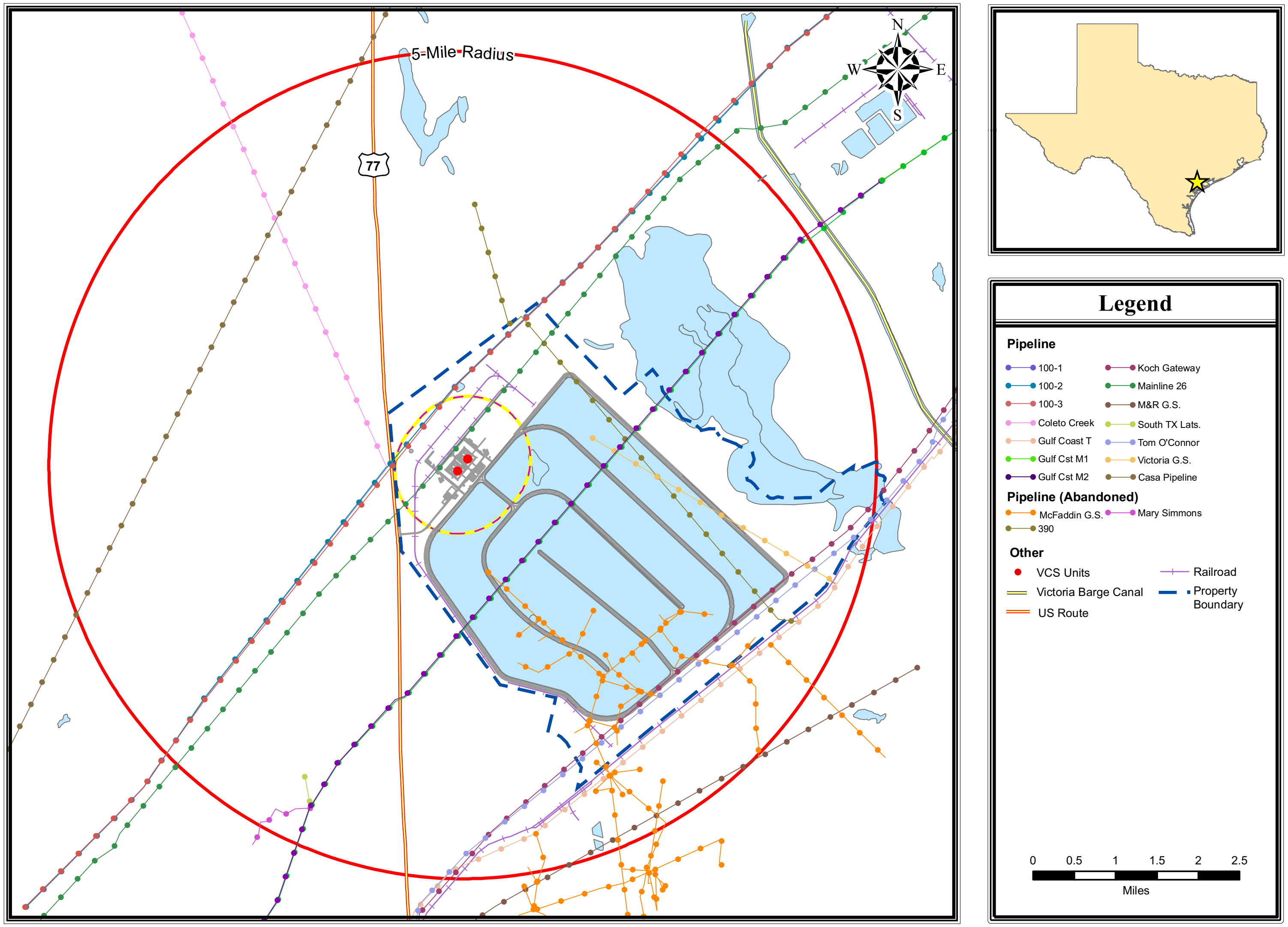

Figure 2.2-202 Pipelines Within the 5-Mile VCS Site Vicinity

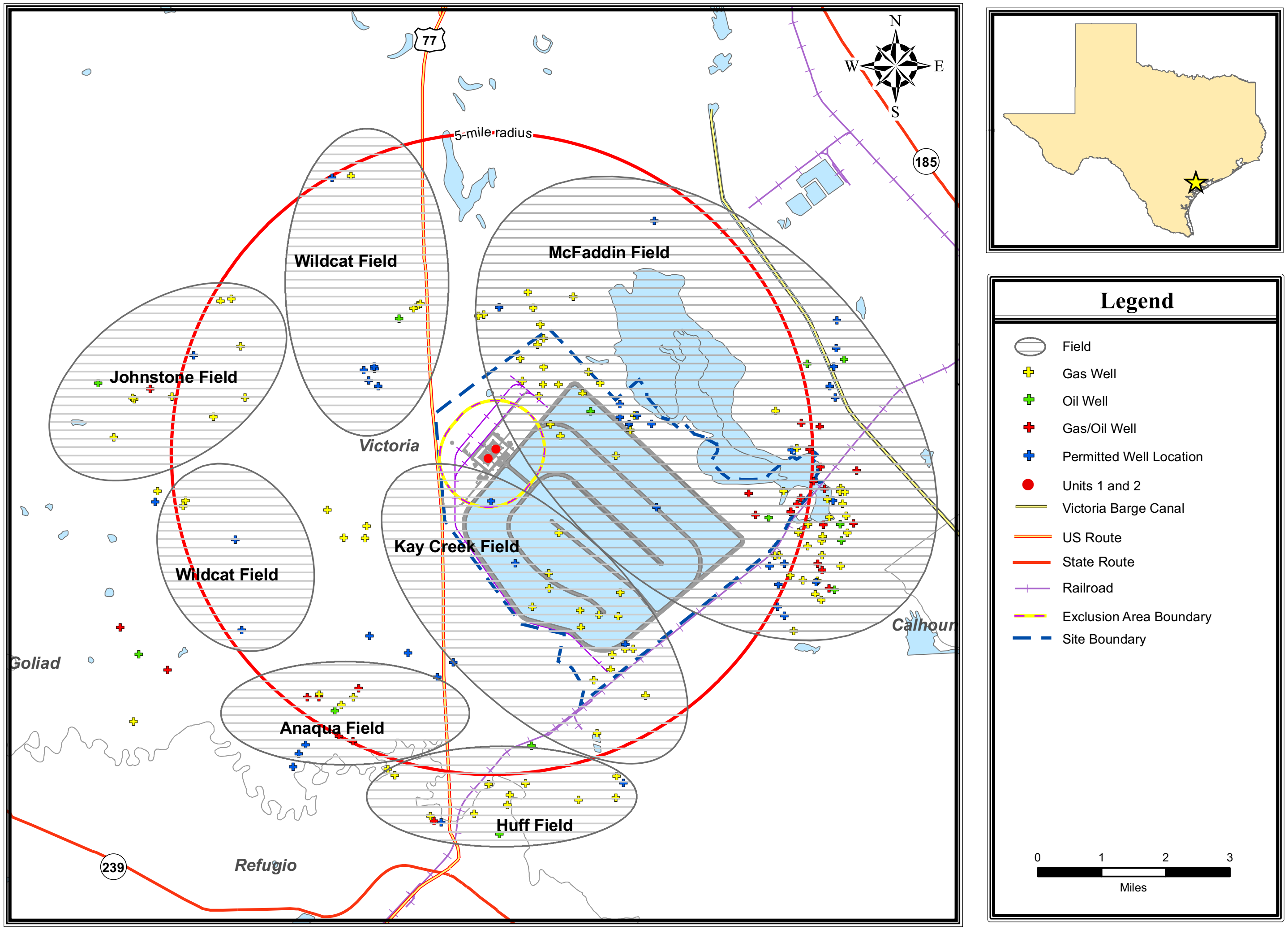

Figure 2.2-203 Gas/Oil Wells and Fields Within the 5-Mile VCS Site Vicinity

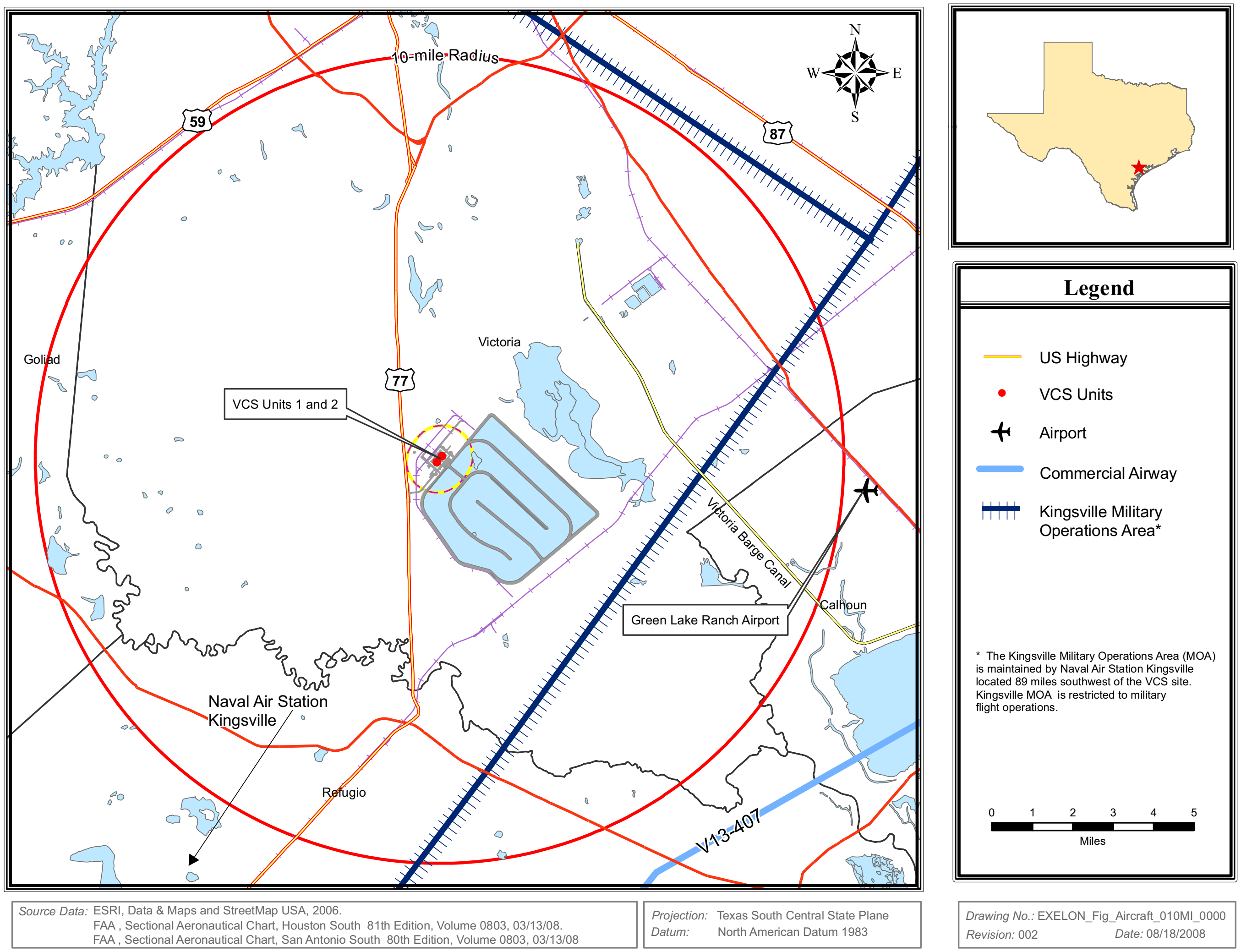

Figure 2.2-204 Airports and Airways Within the 10-mile VCS Site Vicinity