2.2S Nearby Industrial, Transportation, and Military Facilities

The purpose of this section is to establish whether the effects of potential accidents on site or in the vicinity of the site from present and projected industrial, transportation, and military installations and operations should be used as design basis events for plant design parameters related to the selected accidents. To meet the guidance in Regulatory Guide (RG) 1.206, all facilities and activities within five miles of STP 3 & 4 were considered. Facilities and activities at greater distances were included as appropriate to their significance.

2.2S.1 Locations and Routes

The following site-specific supplement addresses COL License Information Item 2.6.

Potential hazard facilities and routes within the vicinity (five miles) of STP 3 & 4, and airports within 10 miles of STP 3 & 4 were identified along with significant facilities at a greater distance in accordance with RG 1.206, RG 1.91, RG 4.7, and relevant sections of 10 CFR Parts 50 and 100.

An investigation of the potential external hazard facilities and operations revealed that within five miles of STP 3 & 4, there are three significant industrial facilities, five natural gas transmission pipelines, five chemical pipelines, four natural gas gathering pipelines, and five active natural gas and/or oil fields with active extraction wells identified for further analysis. An evaluation of major transportation routes within the vicinity of STP 3 & 4 identified four roads, two airways, and one navigable waterway for assessment (References 2.2S-1 through 2.2S-26 and Reference 2.2S-62).

Potential hazard analysis of internal events includes STP 1 & 2 and onsite chemical and chemical storage facilities.

A site vicinity map (Figure 2.2S-1) details the following identified facilities and road and waterway transportation routes:

Significant Industrial Facilities within Five Miles

- OXEA Corporation (formerly Celanese)
- Port of Bay City Operations
  - Gulfstream Terminal and Marketing
  - GulfMark Energy
- STP 1 & 2

Transportation Routes within Five Miles

- Farm-to-Market (FM) 521 Road
- FM 1095

- FM 1468
- FM 3057
- Colorado River

Figure 2.2S-2 illustrates the following identified natural gas and chemical pipelines, and active natural gas and/or oil extraction fields located within five miles of STP 3 & 4:

Natural Gas Transmission Pipelines

- Dow Pipeline Company
- Houston Pipeline Company, L.P.
- Penn Virginia Oil & Gas, L.P.
- Texas Eastern Transmission, L.P.
- Enterprise Products Operating, L.P.

Chemical Pipelines

- Seadrift Pipeline Corporation (ethylene gas)
- OXEA Corporation (propylene)
- OXEA Corporation (oxygen)
- OXEA Corporation (nitrogen)
- OXEA Corporation (ethylene)

Natural Gas Gathering Pipelines

- Acock/Anaqua Operating Co., L.P.
- Houston Pipeline Company, L.P.
- Kinder Morgan Tejas Pipeline, L.P.
- Santos USA Corporation

Natural Gas/Oil Extraction Fields

- Duncan Slough
- Cane Island
- Petrucha

- Grand Slam
- Wadsworth

An evaluation of nearby facilities and transportation routes within 10 miles of STP 3 & 4 revealed there are two industrial facilities that were significant enough to be identified as potential hazard facilities: Equistar Industries, located approximately seven miles east of STP 3 & 4, and Matagorda Waste Disposal and Water Supply Corporation, located approximately nine miles southeast of STP 3 & 4 (References 2.2S-27 through 2.2S-30). There were two airways identified that operate within 5 to 10 miles of the plant (Reference 2.2S-31). There were no identified hazard facilities, routes, or activities greater than 5 to 10 miles that were significant enough to be identified. The closest military base is Ingleside Naval Station located in Ingleside Texas, approximately 90 miles southwest of the STP site.

Figure 2.2S-1 illustrates the following identified Industrial Facilities within 10 miles of STP 3 & 4, including:

Significant Industrial Facilities within 5 to 10 Miles

- Equistar Industries
- Matagorda Waste Disposal and Water Supply Corporation

Figure 2.2S-3 illustrates the following identified airports and airway routes within 10 miles of STP 3 & 4, including:

Airport and Airway Routes within 10 Miles

- STP Corporate Helipad
- Airway V-70
- Airway V-20

Items illustrated in Figures 2.2S-1, 2.2S-2, and 2.2S-3 are described in Subsection 2.2S.2.

2.2S.2 Descriptions

The following site-specific supplement addresses COL License Information Item 2.6.

2.2S.2.1 Description of Facilities

In accordance with RG 1.206, six facilities were identified for review:

- STP 1 & 2
- OXEA Corporation
- The Port of Bay City

  - Gulfstream Terminal and Marketing LLC
  - GulfMark Energy
- Equistar
- Matagorda Waste Disposal and Water Supply Corporation

Table 2.2S-1 provides a concise description of each facility, including its primary function and major products, as well as the number of persons employed.

2.2S.2.2 Description of Products and Materials

A more detailed description of each of these facilities, including a description of the products and materials regularly manufactured, stored, used, or transported, is provided in the following subsections. As provided in RG 1.78, chemicals stored or situated at distances greater than five miles from the plant do not need to be considered unless they have been determined to have a significant impact on the proposed facilities. No other facilities or storage locations have been identified that could have a significant impact on the STP site. Therefore, further analysis beyond these six facilities is not required.

2.2S.2.2.1 STP 1 & 2

STP 1 & 2 are located approximately 1500 feet southeast of STP 3 & 4. STP 1 & 2 are each 1329 MWe Westinghouse Electric Company, LLC pressurized water reactors (PWRs) licensed by the NRC. STP 1 & 2 have been in commercial operation since 1988 and 1989, respectively. The chemicals identified for possible analysis and their locations at the STP 1 & 2 site are presented in Table 2.2S-2. There are approximately 1300 people currently employed at STP 1 & 2.

2.2S.2.2.2 OXEA Corporation

The OXEA Corporation, formerly Celanese, is a chemical manufacturing facility located approximately 4.3 miles north-northeast of STP 3 & 4. In December of 2006, Advent International purchased selected businesses of Celanese Chemicals and European Oxo, a joint venture of Celanese and Degussa. The companies were consolidated into a new company, OXEA. (The shipping operations and a small portion of the plant that manufactures vinyl acetate remain under the operation of Celanese.) A variety of chemical products are produced at the site, including organic chemicals (basic and industrial), cyclic organic crudes, organic dyes, and pigments. OXEA Corporation employs approximately 260 individuals at the Bay City site; OXEA Corporation has 130 permanent employees; Celanese has 30 permanent employees; and there are approximately 100 contractors on site. No further expansion of this site is planned. Table 2.2S-3 summarizes the quantity of hazardous materials currently stored at the plant and the applicable toxicity limits.

OXEA Corporation receives and ships materials by rail, truck, barge, and pipeline. The facility ships tank rail cars on the Union Pacific rail line spur that travels from Bay City to Blessing. Tank rail cars are also shipped on the Burlington Northern Santa Fe rail

line that runs east from the plant main line and then to Bay City. The tank trucks are shipped and received via FM 3057 and FM 2668. Neither the truck nor the rail transport routes approach closer to STP 3 & 4 than the storage location of the chemicals at OXEA. OXEA Corporation also ships materials in barges along the Colorado River. Approximately 360 barges per year are shipped on the Colorado River. There are four pipelines that carry products into the plant. More detailed information about these pipelines is presented in Subsection 2.2S.2.3.2 (References 2.2S-1 and 2.2S-2).

2.2S.2.2.3 Port of Bay City

The Port of Bay City is a port facility located adjacent to OXEA Corporation along the Colorado River, approximately 4.6 miles north-northeast of STP 3 & 4. The port facility consists of approximately 300 acres of land available for industrial development, a terminal in a turning basin with a modern concrete dock, a metal shed located on the dock, and a liquid cargo dock. Located at the Port of Bay City are two facilities- Gulfstream Terminal and Marketing, LLC, and GulfMark Energy, Inc. A description of each company is provided in Subsections 2.2S.2.2.3.1 and 2.2S.2.2.3.2 (Reference 2.2S-3).

2.2S.2.2.3.1 Gulfstream Terminal and Marketing LLC

Gulfstream Terminal and Marketing, LLC (Gulfstream) operates at the Port of Bay City public wharf located 4.6 miles north-northeast of STP 3 & 4. This terminal has been in operation since 1968 under various owners. Gulfstream was formerly owned by Way Energy from 1984 to 2000. Gulfstream receives barge shipments of refined petroleum products such as gasoline and diesel fuel and stores the products until they are delivered by truck to retail terminals. Gulfstream has seven storage tanks located at its facility. There are six tanks with a capacity of 15,000 barrels each, and a seventh tank with a capacity of 20,000 barrels, bringing the total tank capacity at the facility to approximately 110,000 barrels or 4.62 million gallons. The average inventory at the facility at any given time is not expected to exceed 90% of the total capacity. Gulfstream receives an average of six deliveries a month of refined petroleum products by barge. These receipts average approximately 40,000 barrels or 1.68 million gallons. Table 2.2S-3 summarizes the maximum quantity of potentially hazardous materials stored at the terminal and the applicable toxicity limits. Gulfstream currently employs four workers with potential for a slightly increased workforce.

2.2S.2.2.3.2 GulfMark Energy

GulfMark Energy is also located 4.6 miles north-northeast of STP 3 & 4 at the Port of Bay City. This terminal is used for receipt, storage, and transfer of petroleum crude oil and condensate. After unloading and storage, the product is delivered to retail terminals via truck. A 12-inch pipeline extends from the wharf to one 25,000 barrel (1.05 million gallons) storage tank. Gulfmark Energy receives one or two barge shipments each month. Each shipment consists of approximately 15,000 to 20,000 barrels (630,000 to 840,000 gallons) of petroleum crude oil. The facility has an average monthly inventory of 12,500 barrels. The oil is offloaded in 180-barrel (7560 gallon) truckloads. Table 2.2S-3 summarizes the maximum quantity of potentially

hazardous materials stored at the terminal and the applicable toxicity limits. GulfMark Energy does not employ any permanent workers. However, a worker is present in the morning to check gauges and truck drivers arrive and depart after loading or unloading crude oil (Reference 2.2S-4).

2.2S.2.2.4 Equistar

Equistar Chemicals (Equistar), a subsidiary of Lyondell Chemical Company, is located seven miles east of STP 3 & 4. Equistar encompasses about 2500 acres and employs 194 people, including subcontractors. No further plant expansion is planned. Equistar produces high-density polyethylene (HDPE) plastic resins. These resins serve as building blocks for a variety of industrial and consumer products such as specialized food packaging and grocery and merchandise bags. This facility receives and ships material by both rail and truck. Truck transport is via State Highway 60 due to the bridge limitations on FM 521 (Reference 2.2S-27). As provided in RG 1.78, chemicals stored or situated at distances greater than five miles from the plant do not need to be considered in the evaluation of control room habitability.

2.2S.2.2.5 Matagorda Waste Disposal and Water Supply Corporation

Matagorda Waste Disposal and Water Supply Corporation (Matagorda WD & WSC) is located approximately nine miles southeast of STP 3 & 4 (References 2.2S-28 through 2.2S-30). Matagorda WD & WSC currently employs three workers at the facility. This small waste disposal and water supply corporation provides services to approximately 300 homes and small businesses. Matagorda WD & WSC receives chemicals for water and wastewater treatment by truck. Truck transport is via State Highway 60. As provided in RG 1.78, chemicals stored or situated at distances greater than five miles from the plant do not need to be considered (References 2.2S-28 through 2.2S-30).

2.2S.2.3 Description of Pipelines and Natural Gas/Oil Fields

There are five natural gas transmission pipelines, five chemical pipelines, four natural gas gathering pipelines, and five active natural gas and/or oil fields with active extraction wells within five miles of the plant as depicted in Figure 2.2S-2. A more detailed description of each of the pipelines is presented in the following subsections, including the pipe size, age, operating pressure, depth of burial, location and type of isolation valves, and type of gas or liquid presently carried where available. Information pertaining to the various pipelines is also presented in Table 2.2S-4.

As presented in the following subsections, the natural gas transmission pipeline operated by Dow Pipeline Company presents a greater hazard than the gas wells and oil fields due to the safety controls and features on the wells, and the expected damage radius. Careful control and monitoring of drilling operations minimizes the likelihood of a blowout of a gas well. Blowout preventers are also used to reduce the likelihood and consequences of a blowout. Further, damage from the initial effects of a blowout is usually limited to the immediate vicinity of the well. Another accident in producing wells may occur because of failure of the well head equipment and piping as a result of aging, improper operation or damage by vehicles or construction equipment. Of these, the most serious would be the severance of the well head piping such as to cause

uncontrolled gas release from the well and also a backflow from the gathering line connecting the well to the transmission line. Well head equipment includes flow control valves, shutoff valves, and check valves which would limit flow from the well and/or from the gas transmission line normally supplied by the well.

2.2S.2.3.1 Natural Gas Transmission Pipelines

2.2S.2.3.1.1 Dow Pipeline Company

The transmission pipelines nearest STP 3 & 4 are a 16-inch and a 12.75-inch natural gas transmission pipeline operated by Dow Chemical Company. At the closest approach to STP 3 & 4, these pipelines pass within approximately two miles to the northwest of STP 3 & 4 as depicted in Figure 2.2S-2. The easternmost pipeline, Dow Collegeport, was installed in 1940 and is a 12.75-inch diameter pipeline with an operating pressure of 471 psig. The second pipeline, Dow Powderhorn, was installed in 1954 and is a 16-inch diameter pipeline with an operating pressure of 760 psig. Both pipelines are buried at a depth of 3 to 10 feet. It is not expected that Dow Pipeline Company will carry another product in these pipelines (Reference 2.2S-11).

2.2S.2.3.1.2 Houston Pipeline Company, L.P.

The Houston Pipeline Company, L.P. operates a natural gas transmission pipeline that passes within approximately 2.8 miles north of STP 3 & 4 as depicted in Figure 2.2S-2. The pipeline, Matagorda-Brazoria, was installed in 1964 and is an 8.63-inch diameter pipeline with an operating pressure of 575 psig. The pipeline is buried at a depth of two to three feet with a distance of seven to eight miles between isolation valves. Houston Pipeline Company has no plans for carrying a different product in their pipeline. Dow Pipeline Company's pipeline presents a greater hazard than the Houston Pipeline Company's pipeline due to its proximity to STP 3 & 4, and as such, no further analysis of this pipeline is warranted (Reference 2.2S-12).

2.2S.2.3.1.3 Penn Virginia Oil & Gas, L.P.

The Penn Virginia Oil & Gas, L.P. operates a natural gas transmission pipeline that passes within approximately 3.8 miles northeast of STP 3 & 4 as depicted in Figure 2.2S-2. The pipeline has a diameter of 4.5 inches. It is not expected that a different product will be carried in the pipeline. Dow Pipeline Company's pipeline presents a greater hazard than the Penn Virginia Oil & Gas, L.P. due to its proximity to STP 3 & 4, and as such, no further analysis of this pipeline is warranted (Reference 2.2S-14).

2.2S.2.3.1.4 Texas Eastern Transmission, L.P.

Texas Eastern Transmission, L.P. operates a 30-inch natural gas transmission pipeline that passes within approximately 4.2 miles north of STP 3 & 4 as depicted in Figure 2.2S-2. It is not expected that Texas Eastern will carry a different product in their pipeline. Dow Pipeline Company's pipeline presents a greater hazard than Texas Eastern Transmission, L.P. due to its close proximity to STP 3 & 4, and as such, no further analysis of this pipeline is warranted (Reference 2.2S-10).

2.2S.2.3.1.5 Enterprise Products Operating, L.P.

Enterprise Products Operating, L.P. operates an 8.63-inch natural gas transmission pipeline that passes within approximately 4.2 miles north of STP 3 & 4 as depicted in Figure 2.2S-2. The pipeline was installed in 1969 and has an operating pressure of 750 psig. The pipeline is buried at an average depth of 37 inches. Enterprise Products Operating does not have plans to carry a different product in their pipeline. Dow Pipeline Company's pipeline presents a greater hazard than Enterprise Products Operating, L.P. due to its proximity to STP 3 & 4, and as such, no further analysis of this pipeline is warranted (Reference 2.2S-13).

2.2S.2.3.2 Chemical Pipelines

2.2S.2.3.2.1 Seadrift Pipeline Corporation

The Seadrift Pipeline Company operates a nitrogen pipeline 3.5 miles north of STP 3 & 4 as depicted in Figure 2.2S-2. The pipeline was installed in 1962 with a diameter of 4.5 inches and is buried at a depth of 3 to 10 feet. The pipeline operates with a pressure of 1494 psig. It is not expected that a different product will be carried in the pipeline (Reference 2.2S-15).

2.2S.2.3.2.2 OXEA Corporation Propylene Pipeline

The OXEA Corporation owns a 6.63-inch propylene line that delivers product into the OXEA plant and passes within approximately 4.3 miles north-northeast of STP 3 & 4. The propylene pipeline was built in 1977 and has an operating pressure of 875 psig. The pipeline is buried at a depth of 38 to 40 inches except at road crossings, where it is five feet below the road crest. The isolation valves are at various distances along the pipeline. OXEA Corporation has no plans to carry a different product in the future in the pipeline (Reference 2.2S-16).

2.2S.2.3.2.3 OXEA Corporation Oxygen Pipeline

Air Liquide operates a 12.75-inch oxygen pipeline to the OXEA plant that passes within approximately 4.3 miles north-northeast of STP 3 & 4. The oxygen pipeline is buried at a depth of 38 to 40 inches. This pipeline has an operating pressure of 875 psig. It is not expected that a different product will be carried in the pipeline (Reference 2.2S-17).

2.2S.2.3.2.4 OXEA Corporation Nitrogen Pipeline

Air Liquide operates a 10.75-inch nitrogen pipeline to the OXEA plant and passes within approximately 4.3 miles north-northeast of STP 3 & 4. The nitrogen pipeline is buried at a depth of 38 to 40 inches and has an operating pressure of 875 psig. There are no plans to carry a different product in the pipeline in the future (Reference 2.2S-17).

2.2S.2.3.2.5 OXEA Corporation Ethylene Pipeline

Equistar operates a 10.75-inch ethylene pipeline to the OXEA plant and passes within approximately 4.3 miles north-northeast of STP 3 & 4. The ethylene pipeline was

installed in 1982 and has a normal operating pressure of 1000 to 1300 psig. The ethylene pipeline is buried at a depth of four to six feet. It is not expected that a different product will be carried in the pipeline (Reference 2.2S-18).

2.2S.2.3.3 Gas Gathering Pipelines

2.2S.2.3.3.1 Acock/Anaqua Operating Co., L.P.

Acock/Anaqua Operating Co., L.P. operates a 4.5-inch natural gas gathering line that serves the South Duncan Slough field as depicted in Figure 2.2S-2. This gathering pipeline terminates 1.3 miles northwest of STP 3 & 4. 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 (Reference 2.2S-19).

2.2S.2.3.3.2 Houston Pipeline Company, L.P.

The Houston Pipeline Company, L.P. operates a 4.5-inch natural gas gathering line that passes within approximately 3.3 miles north of STP 3 & 4. This gas gathering pipeline serves the Duncan Slough field. 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 (Reference 2.2S-20).

2.2S.2.3.3.3 Kinder Morgan Tejas Pipeline, L.P.

The Kinder Morgan Tejas Pipeline Company, L.P. operates a 16-inch natural gas gathering pipeline that passes within approximately 4.4 miles northwest of STP 3 & 4. 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 (Reference 2.2S-21).

2.2S.2.3.3.4 Santos USA, Corporation

The Santos USA, Corporation operates a 4.5-inch natural gas gathering pipeline that passes within approximately three miles north-northwest of STP 3 & 4. 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 (Reference 2.2S-62).

2.2S.2.4 Description of Waterways

STP 3 & 4 is located approximately 3.2 miles from the west bank of the Colorado River, a navigable waterway. From the Gulf Intracoastal Waterway, the river winds along a 15.6-mile stretch until it approaches the turning basin located at the Port of Bay City facility, approximately 4.6 miles north-northeast of STP 3 & 4. The Port of Bay City is the only dock/anchorage located within 5 miles of the STP site. The stretch of the Colorado River Channel leading to the port facility is approximately 200 feet in width with an average depth of 12 feet. The turning basin is approximately 700 feet in length by 500 feet in width with an average depth of 12 feet (Reference 2.2S-3).

The Colorado River is used primarily for barge traffic. During the 12-month period from January 2005 through December 2005, there were a total of 208 barge and 314 tanker

upbound trips; and 211 barge and 322 tanker outbound trips recorded. These vessels primarily used the river for the transportation of raw and finished materials to local industrial facilities-predominantly OXEA Corporation and the Port of Bay City terminals. These vessels transported a total of 501,000 tons of commodities in the vicinity of STP 3 & 4. These commodities included 56,000 tons of crude petroleum, 1000 tons of residual fuel oil, 127,000 tons of alcohols, and 317,000 tons of carboxylic acids. Table 2.2S-5 details the total quantity of hazardous materials transported on the Colorado River in the vicinity of STP 3 & 4 (Reference 2.2S-9).

The Colorado River provides makeup water to the main cooling reservoir (MCR). The makeup water system, located at the Colorado River, includes a shoreline pump intake, two buried 108-inch diameter makeup water pipelines, and a discharge outfall at the MCR. The system consists of a traveling screen intake structure, siltation basin, a sharp-crested weir, and a 1200 cfs (cubic feet per second) capacity pump station. The screen intake structure consists of coarse trash racks, stop log guides, and multiple sets of traveling water screens.

The intake structure located on the Colorado River is nonsafety-related. The Ultimate Heat Sink (UHS) provides cooling water to the safety-related plant components. Secondary plant cooling water is provided from the main cooling water reservoir (MCR). Only the MCR receives makeup water directly from the Colorado River; therefore, the makeup intake structure is nonsafety-related, and as such, no further analysis is warranted.

2.2S.2.5 Description of Highways

Matagorda County is traversed by several highways. There are four Farm-to-Market roads (FM) within five miles of STP 3 & 4 as depicted in Figure 2.2S-1. FM 521 is the road with the closest approach to STP 3 & 4. At its closest point, FM 521 is approximately 0.4 miles from STP 3 & 4. FM 521 runs in an east-west direction parallel to the STP site northern fence. To the north of the STP site, FM 1468 runs in a north-south direction and intersects FM 521 approximately one mile from STP 3 & 4. FM 521 intersects FM 1095, which also runs in a north-south direction and is located approximately 4.2 miles to the west of STP 3 & 4. Another road located in the vicinity of STP 3 & 4 is FM 3057. FM 3057 runs in an east-west direction and is located north-northeast of the STP 3 & 4. FM 3057 links OXEA Corporation with FM 2668 (Reference 2.2S-8).

To ascertain which hazardous materials may be transported on the roadways within five miles of STP 3 & 4, the industries discussed in Subsection 2.2S.2.2 were contacted to obtain transportation routes. Of the industries contacted, only the chemicals stored at STP are transported within five miles of STP 3 & 4. Each of the on-site chemicals that had the potential to explode, or form a flammable or toxic vapor cloud, were analyzed to determine safe distances. At the closest approach to the nearest safety related structure, FM 521 is 1955 feet. And, the closest approach to the nearest control room is 2853 feet. In each case the on-site chemical was stored in closer proximity to either the identified safety related structure or the Control Room than the closest approach of FM 521. It was determined that, other than the delivery of chemicals to the STP site, a gasoline tanker may possibly use FM 521.

2.2S.2.6 Description of Railroads

There are no railroads in the vicinity (five miles) of STP 3 & 4.

2.2S.2.7 Description of Airports

Only one helipad, the STP helipad, is located within the vicinity (five miles) of STP 3 & 4. There are no airports located within five miles of the STP site. Additionally, there are no airports within 10 miles of the site with projected operations greater than 500 d2 operations annually or beyond 10 miles with projected operations greater than 1,000 d2 movements per year, where “d” is the distance in statute miles from the site. The closest municipal airport is Palacios Municipal Airport, with 3000 operations per year. Although small, private airstrips may be present in this area, the flights are sporadic and do not pose a threat to the STP site. Because of the distance and the very low number of projected operations per year, no further evaluation of probability of an aircraft crash associated with nearby airports is warranted (References 2.2S-33 through 2.2S-35).

2.2S.2.7.1 Airports

2.2S.2.7.1.1 STP Helipad

The STP site operates its own corporate helipad. The helipad is located east of STP 3 & 4 and is a 30-foot by 30-foot concrete pad. Generally, this helipad is used for executive personnel transport. An average of two to three corporate flights per year make use of the helipad. Helicopters using the helipad are generally single main rotor helicopters. Life Flight out of Houston has landed their largest helicopter at this helipad during an exercise-its gross weight was 7718 pounds. There have been no accidents associated with the helipad. No further analysis of this helipad is warranted (References 2.2S-5 through 2.2S-7).

2.2S.2.7.2 Aircraft and Airway Hazards

RG 1.206 and NUREG-0800 state that the risks due to 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 at least five miles from military training routes, and, (3) plant is at least two statute miles beyond the nearest edge of a federal airway. The STP 3 & 4 site fails to meet Item 3 of the acceptance criteria.

The centerline of Airway V-70 is approximately 3.5 miles northwest of the site, and the centerline of Airway V-20 is approximately 9.6 miles northwest of the STP site, as depicted in Figure 2.2S-3 (Reference 2.2S-31). The width of a federal airway is eight nautical miles- four miles on each side of the centerline-placing the V-70 airway closer to the plant than two miles to the nearest edge. Because of the proximity to STP 3 &

4, the criteria set in Section 3.5.1.6 of NUREG-0800-plant is at least two statute miles beyond the nearest edge of a federal airway (V-70)-is not met.

Therefore, a calculation to determine the probability of aircraft accidents that could possibly result in radiological consequences for the STP site was conducted following Department of Energy (DOE) Standard DOE-STD-3014-96. The analysis provided an estimate of the total impact frequency of aircraft per year into the facility-1.16 x 10^{-7}. This meets the NUREG 0800 criteria of about 10^{-7}. When estimating the number of operations along V-70, the number of operations at each of the airports-Palacios Municipal Airport, and Scholes International Airport (the terminal points of airway V-70)-were equally divided among the airways for each airport in order to determine the potential number of operations along the V 70 airway. This is a very conservative assumption since general aviation aircraft mainly fly under Visual Flight Rules or Instrument Flight Rules condition and under new FAA regulations, most commercial and military aircraft will fly point to point rather than in specific airways.

2.2S.2.8 Projections of Industrial Growth

Matagorda County does not have a Comprehensive County Plan or similar documentation. The Office of Economic Development has indicated that there are currently no known plans to develop any industrial facilities within five miles of the STP site. As previously noted, none of the current industries within the vicinity have any current plans for expansion.

2.2S.3 Evaluation of Potential Accidents

The following site-specific supplement addresses COL License Information Item 2.7.

An evaluation of the information provided in Subsections 2.2S.1 and 2.2S.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 criteria in 10 CFR Parts 20, 52.17, 50.34, 100.20, and 100.21, using the guidance contained in Regulatory Guides (RG) 1.78, 1.91, 4.7, and 1.206.

2.2S.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 (Reference 2.2S-64). The following accident categories were considered in selecting design basis events: explosions, flammable vapor clouds (delayed ignition), toxic chemicals, fires, collisions with the intake structure, and liquid spills. The postulated accidents within these categories were analyzed at the following locations:

- Nearby transportation routes (FM 521, the Colorado River, and Dow Pipeline Company natural gas transmission pipelines)

- Nearby chemical and fuel storage facilities (OXEA Corporation, Port of Bay City, Gulfstream Terminal and Marketing LLC and GulfMark Energy)
- Onsite chemical storage (STP 1 & 2) - The chemicals used in STP 3 & 4 are similar to the chemicals used in STP 1 & 2 and are not stored any closer than the determined safe distances identified in the following subsections.

2.2S.3.1.1 Explosions

Accidents involving detonations of explosives, munitions, chemicals, liquid fuels, and gaseous fuels were considered for facilities and activities either on site or within the vicinity of the plant, where such materials are processed, stored, used, or transported in quantity. The effects of explosions are a concern in analyzing 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 were evaluated in accordance with NRC RG 1.91, Revision 1, (RG 1.91) (References 2.2S-41 and 2.2S-49). RG 1.91 cites one psi as a conservative value of peak positive incident overpressure, below which no significant damage would be expected. Conservative assumptions were used in determining the “safe distance” (i.e., the minimum separation distance required for an explosive force to not exceed one psi peak incident pressure). With the exception of the natural gas transmission pipeline, in each of the explosion scenario analyses, the volume of vapor at the upper flammability limit (UFL), specified in NUREG 1805 (Section 15.12(3)), capable of occupying the largest vessel was considered available for combustion and an explosion yield factor of 100% was applied to account for an in-vessel confined explosion (Reference 2.2S-65). 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 2.2S-49). The yield factor is an estimation of the explosion efficiency, or a measure of the portion of the flammable material participating in the explosion. The onsite chemicals (Table 2.2S-6), offsite chemical storage (Table 2.2S-7), hazardous materials transported on navigable waterways (Table 2.2S-8), and hazardous materials potentially transported on FM 521 were evaluated to ascertain which hazardous materials had the potential to explode. The effects of these explosion events from both internal and external sources are summarized in Table 2.2S-9, and are described in the following subsections relative to the release source.

2.2S.3.1.1.1 Highways

The nearest safety-related structure, the control building, is located more than 2700 feet away, at its closest point of approach, from FM 521. Industries in the area that use, store, and transport chemicals were contacted to identify their transportation routes and quantities of transported chemicals. As can be seen on Figure 2.1S-1, Texas State Highways 35 and 60, and US Highway 59 are the major transportation routes traversing the area. Highway transportation of large quantities of chemicals

occur primarily on these routes. FM 521 is a rural road that can be used for local delivery, but is not expected to be used for large shipments of chemicals because it does not provide a direct route to or from any known chemical source or storage location. Therefore, using recognized quantity-distance relationships, it was determined that gasoline delivery tankers traveling on FM 521 provided the greatest danger from explosions on transportation routes within five miles of STP 3 & 4. Delivery of chemicals to the site was also evaluated, but determined to be bounded by the evaluation performed for the onsite storage quantities in Subsection 2.2S.3.1.1.4. The maximum quantity of the gasoline assumed to be transported on FM 521 was 50,000 pounds or 9000 gallons (RG 1.91). An evaluation was conducted using the TNT equivalency methodologies described in Subsection 2.2S.3.1.1. The results indicate that the safe distance for this quantity of gasoline is 266 feet, which is less than the minimum separation distance from the control building to the closest point of approach on FM 521, more than 2700 ft away (Table 2.2S-9). The STP 3 & 4 transmission lines cross FM 521 in four separate corridors, a single corridor to the west that is not credited as a required offsite source, a double corridor to the north containing three creditied offsite sources, and a single corridor to the east containing two credited offsite sources. The north and east corridors are separated on FM 521 by over one mile. Because of this separation, a gasoline tanker explosion on FM 521 under the north corridor transmission lines would not affect the eastern lines, nor would an explosion under the eastern lines affect the northern lines. Section 8.2 provides a description of the transmission corridors and Figure 1.2-37 shows where the transmission corridors cross FM 521. Therefore, an explosion from potentially transported hazardous materials on FM 521 would not adversely affect the safe operation or shutdown of STP 3 & 4.

2.2S.3.1.1.2 Pipelines

Dow Pipeline Company operates two natural gas transmission pipelines within the vicinity of the STP site. The nearest safety-related structure, the control building, is more than 10,000 feet away from the analyzed release point, the closest approach of the nearest natural gas transmission pipeline. In order to conservatively evaluate a potential explosion from the natural gas transmission pipeline, a worst-case scenario was considered involving the immediate deflagration of the vapor coming out of the pipe creating an explosion and ensuing flare. In this scenario, it was assumed that the pipe had burst open, leaving the full cross-sectional area of the pipe completely exposed to the air. It was also assumed that the ignition source existed at the break point and that the duration of the release was 10 minutes. The safe distance to one psi overpressure was determined to be 7577 feet, which is less than the minimum separation distance to the control building of more than 10,000 ft away (Table 2.2S-9). The results indicate that overpressures from an explosion from a rupture in the Dow Pipeline Company natural gas transmission pipeline would not adversely affect the safe operation or shutdown of STP 3 & 4.

The chemical pipelines containing nitrogen, propylene, oxygen, and ethylene are treated as if the total quantity of the chemical gas in each of the pipelines is stored and released at the OXEA Corporation. These releases from the chemical pipelines were conservatively evaluated as continuous direct sources where the total quantity

throughout the pipeline structure is released over a 10-minute period. The results are reported with the offsite chemical analysis in Table 2.2S-7.

2.2S.3.1.1.3 Waterway Traffic

The nearest safety-related structure, the STP 3 Control Room, is located approximately 15,974 feet from the west bank of the Colorado River, a navigable waterway. From the Gulf Intracoastal Waterway, the river winds north along a 15.6-mile stretch until it approaches the turning basin located at the Port of Bay City facility, approximately 4.6 miles north-northeast of STP 3 & 4. The hazardous materials transported on barges and chemical parcel tankers that were identified for further analysis with regard to explosion potential were: n-butanol, isobutanol, acetic acid, n-butyl acetate, vinyl acetate, and gasoline. The maximum quantity of n-butanol, isobutanol, n-butyl acetate, and vinyl acetate assumed to be carried on a vessel is 380,000 gallons. The maximum quantity of acetic acid assumed to be carried on a single vessel is 500,000 gallons. The maximum quantity of gasoline assumed to be carried on a single vessel is 1,680,000 gallons. The results, using the conservative methodology described in Subsection 2.2S.3.1.1, indicate that the safe distances are less than the shortest distance between the STP 3 Control Room and the closest navigable point of approach on the Colorado River (Table 2.2S-9). The safe distances are:

n-butanol	896 feet
isobutanol	888 feet
acetic acid	814 feet
n-butyl acetate	885 feet
vinyl acetate	880 feet
gasoline	1517 feet

Therefore, an explosion from any of the identified chemicals potentially transported on navigable waters in the Colorado River would not adversely affect the safe operation or shutdown of STP 3 & 4.

2.2S.3.1.1.4 Onsite Chemical Storage/STP 1 & 2

STP 3 & 4 are located close to the existing STP 1 & 2 chemical storage locations. The hazardous materials stored on site that were identified for further analysis with regard to explosion potential were gasoline (12,000 gallon above ground storage tank), hydrazine, and hydrogen. A conservative analysis using the TNT equivalency methods described in Subsection 2.2S.3.1.1 was used to determine safe distances for the identified hazardous materials. The results indicate that the safe distances are less than the minimum separation distance from the nearest safety-related structure-the STP 3 Reactor Building-to each storage location. The safe distance for the 12,000-gallon gasoline tank is 296 feet; for hydrazine, 86 feet; and for hydrogen, 1048 feet (Table 2.2S-9). Gasoline is stored approximately 1771 feet; hydrazine approximately 2518 feet; and hydrogen 1563 feet; from the nearest safety-related structure-the STP 3 Reactor Building-for STP 3 & 4. Therefore, an explosion from any of the onsite

hazardous materials evaluated would not adversely affect the safe operation or shutdown of STP 3 & 4. The chemicals used in STP 3 & 4 are similar to the chemicals used in STP 1 & 2 and are not stored any closer than the determined safe distances identified above.

2.2S.3.1.1.5 Offsite Facilities

The OXEA Corporation, located approximately 22,841 feet, and the Port of Bay City, Gulfstream Terminal and Marketing LLC and GulfMark Energy facilities, located approximately 24,244 feet, from the nearest safety-related structure for STP 3 & 4-the STP 3 Control Room- are the facilities of concern within the vicinity of the STP site. The hazardous material stored at GulfMark Energy identified for further analysis with regard to explosion potential was crude petroleum. The gasoline storage at Gulfstream Terminal and Marketing LLC is bounded by the gasoline barge transported on the Colorado River which passes closer to STP 3 & 4. The hazardous materials stored at OXEA Corporation identified for further analysis were: 1-hexene, 1-octene, 2-hexene, acetaldehyde, acetic acid, acetone, cyclohexylamine, hydrazine, dimethyl sulfide, ethyl acetate, ethylene, hydrogen, isobutanol, isobutyl acetate, isobutyraldehyde, methane, n-butanol, n-butyl acetate, n-butyraldehyde, n-propyl acetate, n-propyl alcohol, propionaldehyde, propylene, and vinyl acetate. The results, using the methodology described in Subsection 2.2S.3.1.1, indicate that the safe distances are less than the minimum separation distances from the STP 3 Control Room to the storage locations for any of the identified chemicals (Table 2.2S-9). Propylene resulted in the largest safe distance, 8724 feet, which is less than the distance of 22,841 feet to the nearest safety-related structure for STP 3 & 4. Therefore, damaging overpressures from an explosion resulting from a complete tank or pipeline failure at the offsite facilities evaluated would not adversely affect the operation or shutdown of STP 3 & 4.

2.2S.3.1.2 Flammable Vapor Clouds (Delayed Ignition)

Flammable materials in the liquid or gaseous state can form an unconfined vapor cloud that can drift towards the plant before an ignition event. Flammable chemicals released into the atmosphere can form vapor clouds, dispersing 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 fast enough to create a detonation, an explosive force is generated.

The potential onsite chemical storage (Table 2.2S-6), offsite chemical storage (Table 2.2S-7), hazardous materials transported on navigable waterways (Table 2.2S-8), and hazardous materials transported on FM 521 were evaluated to ascertain which hazardous materials had the potential to form flammable vapor clouds and vapor cloud explosions. For those chemicals with an identified flammability range, the Areal Locations of Hazardous Atmospheres (ALOHA) Version 5.4.1, air dispersion model or the Dense Gas Dispersion (DEGADIS) model, Version 2.1, was used to determine the distances that the vapor cloud could exist in the flammability range, thus presenting the possibility of ignition and potential thermal radiation effects (Reference 2.2S-48 and 2.2S-58).

The identified chemicals were then evaluated to determine the possible effects of a flammable vapor cloud explosion. For the gasoline barge on the Colorado River and the crude petroleum tank at GulfMark Energy, the safe distance for explosion was determined using the TNT equivalent methodologies presented in RG 1.91 and FM Global (Reference 2.2S-41 and Reference 2.2S-49). ALOHA was used to model the worst-case accidental vapor cloud explosion for the remaining identified chemicals, including the safe distances and overpressure effects at the nearest safety-related structure. To model the worst case in ALOHA, detonation was chosen as the ignition source. The safe distance was measured as the distance from the spill site to the location where the pressure wave is at one psi overpressure. Conservative assumptions were used in the ALOHA analyses for both meteorological inputs and identified scenarios. The following meteorological assumptions were used as inputs to the computer model, ALOHA: F (stable) stability class with a wind speed of one m/sec; ambient temperature of 25oC; relative humidity of 50%; cloud cover of 50%; and atmospheric pressure of one atmosphere. “F” stability and a wind speed of one m/sec represent the worst 5% of meteorological conditions observed at a majority of nuclear plant sites (Reference 2.2S-42 and 2.2S-61). For each of the identified chemicals in the liquid state, it was conservatively assumed that the entire contents of the vessel leaked, forming a one-centimeter-thick puddle where accommodated by the model. This provided 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 was conservatively assumed that the entire contents of the vessel/pipeline were released over a 10 minute period into the atmosphere as a continuous direct source (Reference 2.2S-47). The effects of flammable vapor clouds and vapor cloud explosions from internal and external sources are summarized in Table 2.2S-10 and are described in following subsections relative to the release source.

2.2S.3.1.2.1 Highways

The nearest safety-related structure for STP 3 & 4, the control building, is located more than 2700 ft away at its closest distance to FM 521. The hazardous material potentially transported on FM 521 that was identified for further analysis with regard to the potential for forming a flammable vapor cloud capable of delayed ignition following an accidental release was gasoline. The methodology presented in Subsection 2.2S.3.1.2 was used for determining the distance from the accidental release site where the vapor cloud is within the flammability limits. It was conservatively estimated that the vessel carried and released 50,000 pounds or 9,000 gallons of the selected chemical. The results for the 9000-gallon gasoline tanker indicate that any plausible vapor cloud that can form and mix sufficiently under stable atmospheric conditions will have a concentration less than the LFL before reaching the control building. The distance to the LFL boundary for gasoline is 408 feet. Gasoline was also evaluated using the methodology presented in Subsection 2.2S.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 one psi peak incident pressure impact from the drifted gasoline vapor cloud, is less than the shortest distance to the control building from any point on FM 521. The safe distance for this quantity of gasoline was determined to be 1035 feet (Table 2.2S-10). Therefore, a flammable vapor cloud

ignition or explosion from a 9000-gallon gasoline tanker transported on FM 521, would not adversely affect the safe operation or shutdown of STP 3 & 4.

2.2S.3.1.2.2 Pipelines

Dow Pipeline Company operates two natural gas transmission pipelines within the vicinity of the STP site. At its closest distance, these pipelines pass well beyond 10,000 feet of the nearest safety-related structure for STP 3 & 4-the control building. As described in Subsection 2.2S.3.1.1.2, the nearest Dow Pipeline Company natural gas transmission pipeline also represents the bounding design basis case for flammable vapor clouds and vapor cloud explosions. In order 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 was considered involving the release of natural gas directly into the atmosphere resulting in a vapor cloud. As the modeled vapor cloud travels towards STP 3 & 4, it is plausible that the cloud concentration could become flammable along its path. The results indicate that under this scenario, the flammable vapor cloud does not exist at distances beyond 492 feet downwind (distance to LFL) from the pipe break and the ensuing explosion produces a peak incident pressure of one psi at a distance of 1002 feet. Therefore, the safe distance for the vapor cloud explosion is 1494 feet. This distance is significantly less than the distance from the pipeline to the nearest safety-related structure for STP 3 & 4. Therefore, a flammable vapor cloud ignition or explosion from a rupture in the Dow Pipeline Company natural gas transmission pipeline would not adversely affect the safe operation or shutdown of STP 3 & 4 (Table 2.2S-10). As discussed in Subsection 2.2S.3.1.1.2, the chemical pipelines are conservatively treated as if the total quantity of the chemical was stored and released at the OXEA Corporation. The results are reported with the offsite chemical analyses in Subsection 2.2S.3.1.2.5.

2.2S.3.1.2.3 Waterway Traffic

The nearest safety-related structure for STP 3 & 4-the STP 3 Control Room-is located approximately 15,974 feet from the west bank of the Colorado River, a navigable waterway. The hazardous materials transported on barges or chemical parcel tankers that were identified for further analysis with regard to forming a flammable vapor cloud capable of delayed ignition following an accidental release are: n-butanol, isobutanol, acetic acid, n-butyl acetate, vinyl acetate, and gasoline. An analysis was conducted for the identified hazardous materials. The conservative methodology presented in Subsection 2.2S.3.1.2 was used to determine the distance the formed vapor cloud could travel before ignition (the LFL boundary) using the ALOHA or DEGADIS dispersion modeling. The maximum quantity of n-butanol, isobutanol, n-butyl acetate, and vinyl acetate assumed to be spilled on the waterway was 380,000 gallons. The quantity of acetic acid assumed to be spilled on the waterway was 500,000 gallons. For these cases, the maximum surface area of the spill that ALOHA would accommodate-31,400 m^2-was used. The maximum quantity of gasoline assumed to be spilled on the waterway was 1,680,000 gallons. Due to the immense volume of gasoline-1,680,000 gallons-the maximum spill area for a one-centimeter-thick depth would require the gasoline to flow miles down the river away from STP 3 & 4. Therefore, the length of the spill area influencing the STP 3 Control Room was

assumed to be 1500 feet up and down the Colorado River from the spill site, the closest point from the Colorado River to STP 3 & 4, for a total of 3000 feet in river length. The results indicate that any plausible 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 STP 3 & 4. The resultant vinyl acetate and gasoline vapor clouds resulted in the largest traveled distances prior to reaching the LFL boundary. The distance to the LFL boundary for vinyl acetate is 1812 feet, and 5605 feet for gasoline (Table 2.2S-10).

Because each of the identified chemicals has the potential to explode, a vapor cloud explosion analysis was also performed as described in Subsection 2.2S.3.1.2. Results for the vapor cloud explosion analysis indicate that the safe distances, the minimum distances, with drift taken into consideration, required for an explosion to have less than a one psi peak incident pressure, are less than the shortest distance to the nearest safety-related structure for STP 3 & 4 from a probable release point on the Colorado River. The safe distance for vinyl acetate is 3570 feet; for gasoline, 8642 feet; for n-butanol, 1593 feet; for isobutanol 1848 feet; and for n-butyl acetate 1974 feet. For acetic acid, no explosion occurs because the vapor cloud never reached concentrations between the UFL and LFL (Table 2.2S-10). Therefore, a flammable vapor cloud with the possibility of ignition or explosion from a transported hazardous material on the Colorado River would not adversely affect the safe operation or shutdown of STP 3 & 4.

2.2S.3.1.2.4 Onsite Chemical Storage/STP 1 & 2

STP 3 & 4 are close to the existing STP 1 & 2 chemical storage locations. The hazardous materials stored onsite that were identified for further analysis with regard to forming a flammable vapor cloud capable of delayed ignition following an accidental release of the hazardous material were gasoline, hydrazine, and hydrogen. As described in Subsection 2.2S.3.1.2, dispersion models were used to determine the distance a vapor cloud can travel to reach the LFL boundary once a vapor cloud has formed from an accidental release of the identified chemical. It was conservatively assumed that the entire contents of the gasoline and hydrazine vessels leaked forming a one-centimeter-thick puddle; while, for hydrogen, it was assumed that the entire contents of the tank were released over a 10-minute period as a continuous direct source. The results indicate that any plausible vapor cloud that could form and mix sufficiently under stable atmospheric conditions would be below the LFL boundary before reaching the nearest safety-related structure-the STP 3 Reactor Building. The distance to the LFL boundary for gasoline is 480 feet; for hydrogen, 1362 feet; and for hydrazine the distance to the LFL boundary is less than 33 feet. Gasoline is stored approximately 1771 feet; hydrogen, approximately 1563 feet; and hydrazine approximately 2518 feet from the STP 3 Reactor Building (Table 2.2S-10).

A vapor cloud explosion analysis was also completed as detailed in Subsection 2.2S.3.1.2 in order to obtain safe distances. The results indicate that the safe distances, the minimum distance required for an explosion to have less than a one psi peak incident pressure, are less than the shortest distance to the nearest safety-related structure for STP 3 & 4-the STP 3 Reactor Building-and the storage location of

these chemicals. The safe distance for the 12,000-gallon gasoline tank is 1200 feet; for hydrogen, 1557 feet; and for hydrazine, no explosion occurs. For hydrazine, no explosion occurs because the vapor pressure for hydrazine is sufficiently low enough that not enough vapor is released from the spill for a vapor cloud explosion to occur. Each of these chemicals is stored at a greater distance. Gasoline is stored at approximately 1771 feet; hydrogen approximately 1563 feet; and hydrazine approximately 2518 feet from the nearest safety-related structure-the STP 3 Reactor Building. Therefore, a flammable vapor cloud with the possibility of ignition or explosion formed from the storage of the onsite chemicals analyzed would not adversely affect the safe operation or shutdown of STP 3 & 4 (Table 2.2S-10).

2.2S.3.1.2.5 Offsite Facilities

The OXEA Corporation located approximately 22,841 feet, and the Port of Bay City, Gulfstream Terminal and Marketing LLC and GulfMark Energy facilities, located approximately 24,244 feet, from the nearest safety-related structure-the STP 3 Control Room- operate within the vicinity of the STP site. The hazardous material stored at GulfMark Energy that was identified for further analysis with regard to the potential for delayed ignition of a flammable vapor cloud formed following the accidental release of the hazardous material was crude petroleum--the gasoline storage at the Port of Bay City, Gulfstream Terminal and Marketing LLC and GulfMark Energy is bounded by the gasoline transport on the Colorado River. The hazardous materials stored at OXEA Corporation that were identified for further analysis with regard to the potential for delayed ignition of flammable vapor clouds are: 1-hexene, 1-octene, 2-hexene, acetaldehyde, acetic acid, acetone, cyclohexylamine, hydrazine, carbon monoxide, dimethyl sulfide, ethyl acetate, ethylene, hydrogen, isobutanol, isobutyl acetate, isobutyraldehyde, methane, n-butanol, n-butyl acetate, n-butyraldehyde, n-heptanal, n-propyl acetate, n-propyl alcohol, propionaldehyde, propylene, and vinyl acetate. For ~~1-hexene,~~ 1-octene, 2-hexene, acetaldehyde, acetic acid, isobutanol, isobutyl acetate, isobutyraldehyde, n-butanol, n-butyl acetate, n-butyraldehyde, n-propyl acetate, n-propyl alcohol, propionaldehyde, and vinyl acetate, the maximum allowable surface area of the spill that ALOHA would allow-31,400 m^2-was used due to the large storage quantity of these chemicals. The 1-hexene storage tank at OXEA Corporation is surrounded by an installed berm; therefore, it was assumed that the berm confined the spill, limiting the surface area of the spill to 10,800 ft^2. For the remaining chemicals, it was conservatively assumed that the entire contents of the vessels leaked and formed a one-centimeter-thick puddle, or in the case of the chemicals in the gas state, the entire contents of the tank or pipeline were released over a 10-minute period as a continuous direct source. The results using the methodology described in Subsection 2.2S.3.1.2 indicate that any plausible vapor cloud that could form and mix sufficiently under stable atmospheric conditions would be below the LFL boundary before reaching STP 3 & 4 (Table 2.2S-10). The greatest distance to the LFL boundary-12,672 feet-was for hydrogen and ethylene.

Because each of the identified chemicals has the potential to explode, a vapor cloud explosion analysis was also performed as described in Subsection 2.2S.3.1.2. The results of the vapor cloud explosion analysis indicate that the safe distances-the minimum distances required for an explosion to have less than a one psi peak incident

pressure-are less than the minimum separation distance between the STP 3 Control Room and the release points at OXEA Corporation and GulfMark Energy. The largest determined safe distance was for ethylene, 14,784 feet. Therefore, a flammable vapor cloud with the possibility of ignition or explosion from the storage of chemicals at offsite facilities would not adversely affect the safe operation or shutdown of STP 3 & 4.

2.2S.3.1.3 Toxic Chemicals

Accidents involving the release of toxic chemicals from onsite storage facilities and nearby mobile and stationary sources were considered. Toxic chemicals known to be present onsite or in the vicinity of the STP site, or to be frequently transported in the vicinity were evaluated. NRC RG 1.78, Rev. 1, requires evaluation of Control Room habitability following a postulated external release of hazardous chemicals from mobile or stationary sources, on site or offsite (Reference 2.2S-42).

The potential onsite chemicals (Table 2.2S-6), offsite chemical storage (Table 2.2S-7), hazardous materials transported on navigable waterways (Table 2.2S-8), and hazardous materials potentially transported on FM 521 were evaluated to ascertain which hazardous materials should be analyzed with respect to their potential to form a toxic vapor cloud following an accidental release. The ALOHA air dispersion model was used to predict the concentrations of toxic chemical clouds as they disperse downwind for all facilities and sources except for the gasoline barge, which was analyzed using the Toxic Dispersion Model (TOXDISP), Revision 3, and for carbon monoxide at the OXEA Corporation, which was analyzed using the Flame Acceleration Simulator (FLACS) computer model (Reference 2.2S-68). 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 was determined using ALOHA or TOXDISP or FLACS. The ALOHA model was also used to predict the concentration of the chemical in the Control Room following a chemical release to ensure that, under worst-case scenarios, Control Room operators will have sufficient time to take appropriate action.

The IDLH 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 IDLHs 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. Where an IDLH was 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, were used as the toxicity concentration level. Conservative meteorological assumptions were used: F (stable) stability class with a wind speed of one m/sec; ambient temperature of 25°C; relative humidity of 50%; cloud cover of 50%; and atmospheric pressure of one atmosphere. A Pasquill stability category “F” and a wind speed of one m/sec typically represent the worst five percent of meteorological conditions observed at a majority of

nuclear plant sites (Reference 2.2S-42 and 2.2S-61). It was further assumed that the toxic vapor cloud traveled downwind directly toward the Control Room.

For each of the identified chemicals, it was conservatively assumed that the entire contents of the vessel leaked, forming a one-centimeter-thick puddle, where accommodated by the model. For those identified hazardous materials in the gaseous state, it was conservatively assumed that the entire contents of the vessel or pipeline were released over a 10-minute period into the atmosphere as a continuous direct source (Reference 2.2S-47). The effects of toxic chemical releases from internal and external sources are summarized in Table 2.2S-11 and are described in the following subsections relative to the release sources.

2.2S.3.1.3.1 Highways

The nearest Control Room for STP 3 & 4 is located approximately 2853 feet at its closest distance to FM 521. Gasoline was the hazardous material potentially transported on FM 521 that was 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. The methodology presented in Subsection 2.2S.3.1.3 was used for determining the distance from the release site to the point where the toxic vapor cloud reaches the IDLH boundary. For gasoline, the TWA toxicity limit was conservatively used because no IDLH is available for this hazardous material. The TWA is the average value of exposure over the course of an eight-hour work shift. The maximum concentration of gasoline attained in the Control Room during the first hour of the release was determined. In this scenario, it was conservatively estimated that the transport vehicle lost the entire contents-50,000 pounds or 9000 gallons. The results indicate that any vapor cloud that forms following an accidental release of gasoline on FM 521 and travels toward the Control Room would not achieve an airborne concentration greater than the TWA in the Control Room (Table 2.2S-11). Therefore, the formation of a toxic vapor cloud following an accidental release of gasoline transported on FM 521 would not adversely affect the safe operation or shutdown of STP 3 & 4.

2.2S.3.1.3.2 Pipelines

The Dow Pipeline Company operates two natural gas transmission pipelines within the vicinity of the STP site. At its closest distance, these pipelines pass within approximately 11,089 feet of the nearest Control Room for STP 3 & 4. The Dow Pipeline Company natural gas transmission pipelines carry natural gas and are not expected to carry a different product in the future. Natural gas is not considered toxic and there is no IDLH or other toxicity limit identified for this chemical. Therefore, no toxicity analysis is necessary for the natural gas transmission pipelines. As discussed in Subsection 2.2S.3.1.1.2, the chemical pipelines are conservatively treated as if the total quantity of the chemical was stored and released at the OXEA Corporation. The results are reported with the offsite chemical analyses in Subsection 2.2S.3.1.3.5.

2.2S.3.1.3.3 Waterway Traffic

The STP 3 Control Room is located approximately 15,974 feet from the west bank of the Colorado River, a navigable waterway. The plausible chemicals transported on barges or chemical parcel tankers along the Colorado River identified for further analysis with regard to the potential of forming a toxic vapor cloud following an accidental release and traveling toward the Control Room are n-butanol, isobutanol, acetic acid, n-butyl acetate, vinyl acetate, and gasoline. An analysis was conducted for the identified hazardous materials. The conservative methodology outlined in Subsection 2.2S.3.1.3 was used to determine the concentration of a toxic chemical cloud as it disperses downwind toward the Control Room using the ALOHA or TOXDISP dispersion modeling. The maximum quantity of n-butanol, isobutanol, n-butyl acetate, and vinyl acetate assumed to be spilled on the waterway was 380,000 gallons. The quantity of acetic acid assumed to be spilled on the waterway was 500,000 gallons. For these cases, the maximum surface area of the spill that ALOHA would accommodate-31,400 m^2-was used. The maximum quantity of gasoline assumed to be spilled on the waterway was 1,680,000 gallons. Due to the immense volume of gasoline-1,680,000 gallons-the maximum spill area for a one-centimeter-thick depth would require the gasoline to flow miles down the river away from STP 3 & 4. Therefore, the length of the spill area influencing the Control Room was assumed to be 1500 feet up and down the river from the spill site, the closest point from the river to STP 3 & 4, for a total of 3000 feet in river length. The Control Room concentrations of the selected hazardous materials never reach the IDLH or other established toxicity limits (Table 2.2S-11). The greatest distance to an IDLH for the selected hazardous materials was acetic acid and vinyl acetate, where concentrations in the air disperse to a level below their respective IDLH limits 10,032 feet from the spill site. Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials transported on the Colorado River would not adversely affect the safe operation or shutdown of STP 3 & 4.

2.2S.3.1.3.4 Onsite Chemical Storage/STP 1 & 2

The hazardous materials stored on site that were identified for further analysis with regard to the potential of the formation of toxic vapor clouds formed following an accidental release were Freon-11, Freon-12, gasoline (12,000 gallon above ground storage tank), Halon 1301, hydrogen (asphyxiant), sodium hypochlorite, monoethanolamine, hydrazine, nitrogen (asphyxiant), and liquid nitrogen (asphyxiant). As described in Subsection 2.2S.3.1.3, the identified hazardous materials were analyzed using the ALOHA dispersion model to determine whether the formed vapor cloud would reach the Control Room intake and what the concentration of the toxic chemical would be in the Control Room following an accidental release. Hydrogen, nitrogen, and liquid nitrogen concentrations were determined at the Control Room following a 10-minute release from the largest storage vessel. In each case, the concentration of these asphyxiants at the Control Room-1490 ppm hydrogen, 5540 ppm nitrogen, and 1390 ppm liquid nitrogen-would not displace enough oxygen for the Control Room to become an oxygen-deficient environment, nor would they be otherwise toxic at these concentrations (Reference 2.2S-63). The remaining chemical analyses indicate that the Control Room would remain habitable for the worst-case

release scenario. (While, the distance to the selected toxicity limit for gasoline is greater than the distance to the STP 3 & 4 control room, the concentration inside the control room never reached the toxicity limit.) The worst-case release scenario in each of the analyses included the total loss of the largest vessel, resulting in an unconfined one-centimeter-thick puddle under stable atmospheric conditions (Table 2.2S-11). Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials stored onsite would not adversely affect the safe operation or shutdown of STP 3 & 4.

2.2S.3.1.3.5 Offsite Facilities

The OXEA Corporation, located approximately 22,841 feet, and the Port of Bay City, Gulfstream Terminal and Marketing LLC and GulfMark Energy facilities, located approximately 24,244 feet, from STP 3 & 4 operate within the vicinity of the STP site. The hazardous material stored at GulfMark Energy that was identified for further analysis with regard to the potential for forming a toxic vapor cloud following an accidental release and traveling to the Control Room was crude petroleum. (The gasoline storage at the Port of Bay City, Gulfstream Terminal and Marketing LLC, and GulfMark Energy is bounded by gasoline transport on the Colorado River.) The hazardous materials stored at OXEA Corporation that were identified for further analysis with regard to the potential for forming a toxic vapor cloud following an accidental release and traveling toward the Control Room were 1-hexene, 1-octene, 2-hexene, acetaldehyde, acetic acid, acetone, cyclohexylamine, dimethyl sulfide, hydrazine, sodium hypochlorite, carbon dioxide (asphyxiant), carbon monoxide (asphyxiant), ethyl acetate, ethylene (asphyxiant), hydrogen (asphyxiant), isobutanol, isobutyl acetate, isobutyraldehyde, methane (asphyxiant), n-butanol, n-butyl acetate, n-butyraldehyde, n-propyl acetate, n-propyl alcohol, propionaldehyde, nitrogen (asphyxiant), propylene (asphyxiant), and vinyl acetate. Carbon dioxide, carbon monoxide, ethylene, hydrogen, methane, nitrogen and propylene concentrations were determined outside the Control Room following a 10-minute release from the largest storage vessel. In each case, the concentration of the asphyxiants at the Control Room would not displace enough oxygen for the Control Room to become an oxygen-deficient environment, nor would it be otherwise toxic at these concentrations (Table 2.2S-11). The remaining chemical analyses indicate that~~, except for 1-Hexene and carbon monoxide,~~ the distance the vapor cloud could travel prior to falling below the selected toxicity limit was less than the distance to the Control Room. ~~Additionally, in each case, including 1-Hexene and carbon monoxide, the analyses indicate that one hour after an accidental release, the toxic chemical had not reached the Control Room (Table 2.2S-11). After 1 hour, the model assumes that weather conditions or other release circumstances are likely to change such that the vapor cloud would not pose a threat inside the control room.~~ Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials stored offsite would not adversely affect the safe operation or shutdown of STP 3 & 4.

2.2S.3.1.4 Fires

Accidents were considered in the vicinity of the STP 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 in adjacent industrial plants and storage

facilities-chemical, oil and gas pipelines; brush and forest fires; and fires from transportation accidents-were evaluated as events that could lead to high heat fluxes or to the formation of such clouds. The nearest industrial sites are the OXEA Corporation and the Port of Bay City, Gulfstream Terminal and Marketing LLC, and GulfMark Energy facilities, located approximately 4.6 miles north-northeast from STP 3 & 4. Each of the chemicals stored at the OXEA Corporation and Port of Bay City facilities, along with the nearest Dow Pipeline Company natural gas transmission pipeline, and those chemicals transported by barge on the Colorado River, were evaluated in Subsection 2.2S.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 indicated that any formed vapor cloud would dissipate below the LFL before reaching the Control Room. Therefore, it is not expected that there would be any hazardous effects to STP 3 & 4 from fires or heat fluxes associated with the operations at these facilities, transportation routes, pipelines, or barge routes.

Further, the potential for brush, forest or woodland, and onsite fires from storage facilities was evaluated. A cleared area at least 1950 feet wide to the north, south, and west of STP 3 & 4 provides a substantial defensible zone in the unlikely event of a fire originating in brush or spreading to the site as a result of onsite or offsite activities. Additionally, the area to the east of STP 3 & 4 comprises the switchyard and contains no appreciable brush or trees. Therefore, the zone surrounding STP 3 & 4 is of sufficient size to afford protection in the event of a fire. For perspective, the Texas Department of Public Safety recommends a safety zone of only 30 to 50 feet be maintained around structures for protection against wildfires, while California has adopted regulations requiring a fire break of at least 30 feet and a fuel break to 100 feet (Reference 2.2S-50 and 2.2S-51). The safety zone around STP 3 & 4 greatly exceeds these recommended distances, and therefore, it is not expected that there will be any hazardous effects to STP 3 & 4 from fires or heat fluxes associated with wild fires, fires in adjacent industrial plants, or from onsite storage facilities.

2.2S.3.1.5 Collisions with Intake Structure

Because STP is located near a navigable waterway, an evaluation was performed that considered the probability and potential effects of impact on the plant cooling water intake structure and enclosed pumps. Although, makeup water for the onsite main cooling water reservoir for STP 3 & 4 is taken from the Colorado River for normal plant operation, the separate ultimate heat sink, which is not supplied directly from the intake structure on the Colorado River, provides cooling water for the safe shutdown of the plant. Thus, damage to the Colorado River makeup water intake structure would not affect the safe shutdown of STP 3 & 4.

2.2S.3.1.6 Liquid Spills

The accidental release of oil or liquids that may be corrosive, cryogenic, or coagulant were considered to determine if the potential exists for such liquids to be drawn into the plant's makeup water intake structure and circulating water system or otherwise affect the plant's safe operation. In the event that these liquids would spill into the Colorado River, they would not only be diluted by the large quantity of Colorado River

water, but the makeup water intake from the Colorado River is not necessary for the safe shutdown of the plant. Therefore, any spill in the Colorado River would not affect the safe operation or shutdown of STP 3 & 4.

2.2S.3.1.7 Radiological Hazards

The release of radioactive material from STP 1 & 2, as a result of normal operations or as a result of an unanticipated event, would not threaten the safety of STP 3 & 4. The Control Room habitability system for the ABWR provides the capability to detect and protect main Control Room personnel from airborne radioactivity. In addition, safety-related structures, systems, and components for the ABWR have been designed to withstand the effects of radiological events and the consequential releases that would bound the contamination from a release from either of these potential sources.

2.2S.3.2 Effects of Design Basis Events

As concluded in the previous subsections, no events were identified that had a probability of occurrence of greater than 1.0E-7 per year, or 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. Thus, there are no accidents associated with nearby industrial, transportation, or military facilities that are considered design basis events.

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Table 2.2S-1 Description of Facilities - Products and Materials

Site	Concise Description	Primary Function	Number of Persons Employed	Major Products or Materials
OXEA Corporation	OXEA Corporation receives raw chemicals from rail, pipeline, road, and by barge and manufactures basic and industrial chemicals/compounds	Manufacturer of organic chemicals, crudes, organic dyes & pigments	260	Basic organic chemicals, industrial organic chemicals, acetates, aldehydes, crudes, intermediates, dyes and pigments
STP 1 & 2	STP 1 & 2 are each 1329 MWe Westinghouse Electric Company, LLC pressurized water reactors licensed by the NRC	Power Production	About 1300	Electric Power
Port of Bay City/ Gulfstream Terminal and Marketing LLC	Petroleum Transit Station	Receive, store, & transfer petroleum products	4	Gasoline; Diesel oil
Port of Bay City/ GulfMark Energy	Petroleum Transit Station	Receive, store, & transfer petroleum products	None	Petroleum Crude Oil
Equistar	Equistar receives raw chemicals from both rail and road and manufactures HDPE plastic resins	Manufacturer of HDPE plastic resins	194	HDPE plastic resins
Matagorda Waste Disposal and Water Supply Corporation	Water supply and sanitary wastewater treatment plant	Sanitary wastewater treatment plant	3	N/A

Table 2.2S-2 STP Onsite Chemical Storage

Compound	IDLH [1]	Maximum Quantity in Largest Container (lbs)	Storage Location
Sodium Bromide	None established	37,800	ECW/CWI Hypochlorite Tank
Sulfuric Acid	15 mg/m^3	105,000	E/M Shop
			Bldg. 19, WSHE-32
			Bldg. 19, WSHE-19, MEAB 1 & 2, TGB 1 & 2, EM Shop
			Unit 1 demineralizer Area, Neutralization basin
			Plant Demin Area Unit 1 NE Corner outside
			Unit 2 NE Corner Outside, acid storage
			Acid Storage Unit 2
			P/D Lab Bldg 52
Boric Acid	None established	44,100	Bldg. 27, WSHE-32
			Unit 1/2 MEAB
50% Sodium Hydroxide	None established	67,200	Units 1 & 2 Demineralizer
			Bldg. 19, WSHE-32
			Caustic Storage Units 1 & 2
			Unit 1 & 2 MEAB & TGB
			Bldg 44 Nuclear Training
			Bldg 27, WSHE 32
Number 2 Diesel Fuel	None established	588,000	EGDS, DGB Unit 1 & 2, Fire Pump House, NSC
			EGDS, Unit 2, NTF Bldg-44, Gas Island
			Unit 2 Emergency Generator
			Bldg 20 Fab Shop, MOF Tool Room
Freon-11 (Trichlorofluoromethane)	2000 ppm	2917	Bldg 19 Fab Shop, Bldg 27 WSHE 32
			Electric Shop, Bldg 19 WSHE 32
			Bldg 19 WHSE 32
Freon-12 (Dichlorodifluoromethane)	15,000 ppm	55,200	Bldg 20 Fab Shop
			E/M Shop, Bldg 27 WSHE 32
			Bldg 19 WHSE 32

Table 2.2S-2 STP Onsite Chemical Storage (Continued)

Compound	IDLH [1]	Maximum Quantity in Largest Container (lbs)	Storage Location
Fryquel EHC	1000 mg/m^3 as Triphenyl Phosphate	4200	Bldg. 27, WSHE-32, MM shop
			Units 1 & 2 TGB
			Mechanics Shop
			Units 1 & 2 TGB, Bldg 19, WHSE 32
			WHSE-32 Compressed Gas Storage
Gasoline	No IDLH listed; 300 ppm TWA [2]	12,000 gallons	Gas Service Island (aboveground tank) Electric Shop, Bldg 20 Fab Shop
Halon 1301 (Trifluorobromomethane)	40,000 ppm	9150	Vault Bldg-44 NTF Unit 1 & 2 MEAB
Hydrogen	None established-asphyxiant	100,200 ft^3/ bank; 8,350 ft^3/ cylinder	Main Gas Storage
12.5% Sodium Hypochlorite	None established-10 ppm as chlorine	7200 gallons	Cooling water intake/N/W ECW Intake Bldg. 19, WHSE-32
Hydrazine	50 ppm	1260	South of TBG 1 & 2, Bldg-19, WHSE-32 Aux Boiler, Bldg-19, WHSE-32
Monoethanolamine	30 ppm	126,000	SW of TGB 1 & 2 Ethanolamine Storage Tank
Nitrogen	None established-asphyxiant	20,000	Bldg 20 Fab Shop, Bldg 20 Yard, Bldg 27 WHSE-32 Cold Chem Labs, Electric Shop Met Lab, Unit 1 MEAB & TGB, I&C Shop Unit 1 & 2 MEAB &TGB, Switch Yard Bulk Nitrogen Storage MM Shop
Liquid Nitrogen	None established - asphyxiant	92,400	North of Unit 2 Outside protected area

Source - References 2.2S-32, 2.2S-37 through 2.2S-40, and 2.2S-52

[1] IDLH, Immediately Dangerous to Life or Health
[2] TWA, Time-Weighted Average

Table 2.2S-3 Offsite Chemical Storage - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy

Material	Toxicity Limit (IDLH) [2]	Maximum Quantity [1] in Largest Container (lbs)
OXEA Corporation		
1-Hexene	30 ppm ~~TLV-TWA [3]~~TEEL [4]	1,265,000
1-Octene	250 mg/m^3 TEEL [4]	2,010,000
2-Hexene	30 ppm TLV-TWA [3]	3861
2-Methyl Hexanoic Acid	None established	2700
Acetaldehyde	2,000 ppm	866,295
Acetic Acid	50 ppm	9,999,999*
Acetone	2500 ppm	4400
Nickel Catalyst	10 mg/m^3	10,000
Amercor 8780 Cyclohexylamine	30 ppm-TEEL [4]	4000
Amerzine 35 Hydrazine	50 ppm	4000
ATC-AFFF Foam -2-(2-Butoxyethoxy)	None established	30,000
Sodium Hypochlorite	10 ppm as chlorine	30,000
Aluminum Oxide Catalyst (85% Aluminum Oxide)	None established	10,000
Iron Oxide Catalyst (90% iron oxide)	2500 mg/m^3	8000
Zinc Oxide Catalyst (50%)	500 mg/m^3	10,000
C7 heavy ends (C-14 Esters, 71%)	None established	11,520
C8 Catalyst	None established	10,000
C9 heavy ends (C-18 Esters, 71%)	None established	11,520
Carbon Dioxide	40,000 ppm	868,000
Carbon Monoxide	1200 ppm	868,000
Celite (Diatomaceous Earth)	3000 mg/m^3	10,000
Silver (catalyst)	10 mg/m^3	12,250
Silica	3000 mg/m^3	10,000
Aluminum Silicate	10 mg/m^3-TLV [3]	40,000
Diesel	None established	40,000
Diisopropanolamine	None established	32,000
Dimethyl Sulfide	2000 ppm -TEEL [4]	10,000
Drewfloc 2449 (33% Petroleum Distillate)	1000 ppm	4000
Drewsperse 2625B (Potassium Hydroxide)	None established	32,000

Table 2.2S-3 Offsite Chemical Storage - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy (Continued)

Material	Toxicity Limit (IDLH) [2]	Maximum Quantity [1] in Largest Container (lbs)
Ethyl Acetate	2000 ppm	21,800
Ethylene	15,000 ppm - TEEL [4]	470,000
Ethylene Glycol	None established	64,000
G-132 D catalyst (copper oxide 50%)	100 mg/m^3	8,000
G55/G65 Catalyst (aluminum oxide 70%)	None established	10,000
Gasoline	300 ppm -TWA [3]	14,400
Calcium Carbonate	10 mg/m^3	5,000
Hexanoic Acid	None established	99,999*
Hydrogen	Asphyxiant	58,512
Hydroquinone	50 mg/m^3	3,000
Isobutanol	1600 ppm	3,455,333
Isobutyl acetate	1300 ppm	9,999,999*
Isobutyraldehyde	1500 ppm -TEEL [4]	999,999*
Sulfuric Acid	15 mg/m^3	As Batteries
Calcium Oxide (Dust)	25 mg/m^3	40,000
Methane	25,000 ppm -TEEL [4]	47,000
Methane Sulfonic Acid	None established	9,999*
Monoethanolamine	30 ppm	99,999*
N-Butanol	1400 ppm	16,921,268
N-butyl acetate	1700 ppm	9,999,999*
N-Butyraldehyde	2000 ppm - TEEL [4]	3,300,000
N-Heptanal	None established	325,000
N-Heptanoic acid	None established	1,929,855
N-Nonanal	None established	400,000
N-Propyl acetate	1700 ppm	9,999,999*
N-Propyl alcohol	800 ppm	9,999,999*
Nitrogen	Asphyxiant	9,999,999*
Nonanoic acid	None established	9,999,999*
Oxygen	None established	999,999*
Parabenzoquinone	100 mg/m^3	99,999*
Phosphoric acid (85%)	1000 mg/m^3	99,999*
Potassium acetate	None established	99,999*

Table 2.2S-3 Offsite Chemical Storage - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy (Continued)

Material	Toxicity Limit (IDLH) [2]	Maximum Quantity [1] in Largest Container (lbs)
Potassium hydroxide	None established	99,999*
Propionaldehyde	500 mg/m^3 -TEEL [4]	600,000
Propylene	Asphyxiant	740,000
Propylene glycol	None established	999,999*
Sand (silica dust)	30 mg/m^3 -PEL [5]	99,999*
Sodium Hydroxide Solution	None established	999,999*
Sulfolane	None established	99,999*
Sulfuric Acid	15 mg/m^3	999,999*
Lubricating Oil	None established	99,999*
Triphenylphosphine	None established	9,999*
Vanadium Pentaoxide	35 mg V/m^3	9,999*
Zinc Oxide	500 mg/m^3	10,000*
UCON LB-625 Polyalkylene Glycol	None established	99,999*
Vinyl Acetate	500 ppm [6]	3,700,000
Gulfstream Terminal and Marketing LLC		
Gasoline	300 ppm -TWA [3]	20,000 barrels
Diesel Oil	None established	20,000 barrels
GulfMark Energy		
Petroleum Crude Oil	None established	25,000 barrels

Source - References 2.2S-32, 2.2S-36, 2.2S-37, 2.2S-39, 2.2S-40, 2.2S-43 through 2.2S-46, 2.2S-48, 2.2S-52, 2.2S-56, 2.2S-57, 2.2S-59, 2.2S-60, 2.2S-66, and 2.2S-67.

[1]Actual amount of compound in these cases, is the maximum of the reported range on the SARA Title III, Tier II report. This range envelopes an order of magnitude and represents the greatest amount present at the facility during the reporting period. (denoted by *).
[2]Immediately Dangerous to Life or Health (IDLH)
[3]Threshold Limit Value/ Time-Weighted Average (TLV-TWA)
[4]Temporary Emergency Exposure Limit (TEEL)
[5]Permissible Exposure Limit (PEL)
[6]Emergency Response Planning Guideline (ERPG)

Table 2.2S-4 STP 3 & 4 Pipeline Information Summary

Operator	Product	Pipeline Diameter	Pipeline Age	Operating Pressure	Depth of Burial	Distance Between Isolation Valves
Dow Pipeline Company	**Natural Gas Transmission**	**12.75 inches**	1940	471 psig	3 to 10 feet	10 miles
Dow Pipeline Company	**Natural Gas Transmission**	**16 inches**	1954	760 psig	3 to 10 feet	10 miles
Houston Pipeline Company, L.P.	**Natural Gas Transmission**	**8.63 inches**	1964	575 psig	2 to 3 feet	7-8 miles
Penn Virginia Oil & Gas, L.P.	**Natural Gas Transmission**	**4.5 inches**	N/A	N/A	N/A	N/A
Texas Eastern Transmission, L.P.	**Natural Gas Transmission**	**30 inches**	N/A	N/A	N/A	N/A
Enterprise Products Operating, L.P.	**Natural Gas Transmission**	**8.63 inches**	1969	750 psig	37 inches	N/A
Seadrift Pipeline Corporation	**Nitrogen**	**4.5 inches**	1962	1494 psig	3 to 10 feet	N/A
OXEA Corporation	**Propylene**	**6.63 inches**	1977	875 psig	38 to 40 inches	varies
OXEA Corporation/ Air Liquide	**Oxygen**	**12.75 inches**	N/A	875 psig	38 to 40 inches	N/A
OXEA Corporation/ Air Liquide	**Nitrogen**	**10.75 inches**	N/A	875 psig	38 to 40 inches	N/A
OXEA Corporation/ Equistar	**Ethylene**	**10.75 inches**	1982	1000-1300 psig	4 to 6 feet	N/A
Acock/Anaqua Operating Co., L.P.	**Natural Gas Gathering**	**4.5 inches**	N/A	N/A	N/A	N/A
Houston Pipeline Company, L.P.	**Natural Gas Gathering**	**4.5 inches**	N/A	N/A	N/A	N/A
Kinder Morgan Tejas Pipeline, L.P.	**Natural Gas Gathering**	**16 inches**	N/A	N/A	N/A	N/A
Santos USA, Corp.	**Natural Gas Gathering**	**4.5 inches**	N/A	N/A	N/A	N/A

Source - References 2.2S-10 through 2.2S-21, and Reference 2.2S-62

Table 2.2S-5 Hazardous Chemical Waterway Freight, Colorado River

Material	Toxicity Limit (IDLH) [1]	Total Quantity (short tons)
Crude Petroleum	None established	56,000
Residual Fuel Oil	None established	1,000
Alcohols	1400 ppm (Butanol); 1600 ppm (Iso-Butanol)	127,000
Carboxylic Acids	50 ppm (Acetic Acid); 1700 ppm (Butyl Acetate); 500 ppm (Vinyl Acetate) [2]	317,000

Source: References 2.2S-9, 2.2S-37, 2.2S-48, and 2.2S-57

[1] Immediately Dangerous to Life or Health
[2] Emergency Response Planning Guideline

Table 2.2S-6 Onsite Chemical Storage - Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Sodium Bromide	None established	Not flammable	None listed	None listed	No further analysis required
98% Sulfuric Acid	15 mg/m^3	Not flammable	None listed	0.001 mm Hg	No further analysis required- low vapor pressure [1]
Boric Acid	None established	Not flammable	None listed	N/A-solid	No further analysis required
50% Sodium Hydroxide	None established	Not flammable	None listed	Not available	No further analysis required
Number 2 Diesel Fuel	None established	1.3%-6.0%	None listed	0.100 psi @ 100°F	No further analysis required-low vapor pressure [1]
Freon-11 (Trichlorofluoromethane)	2000 ppm	Not flammable	None listed	23.58 psi @ 100°F	Toxicity Analysis
Freon-12 (Dichlorodifluoromethane)	15,000 ppm	Not flammable	None listed	159.599 psi @ 80°F	Toxicity Analysis
Fyrquel EHC fluid	1000 mg/m^3 as Triphenyl Phosphate	Not flammable	None listed	0.17 mm Hg @ 68°F	No further analysis required- low vapor pressure [1]
Gasoline	300 ppm- TWA [2]	1.4%-7.4%	Vapor may explode	292 mm Hg @ 81.4°F	Toxicity Analysis Flammability Analysis Explosion Analysis
Halon 1301 (Trifluorobromomethane)	40,000 ppm	Not flammable	None listed	>1 atm	Toxicity Analysis
Hydrazine	50 ppm	4.7%-100%	Vapor may explode	0.567 psi @ 100°F	Toxicity Analysis Flammability Analysis Explosion Analysis

Table 2.2S-6 Onsite Chemical Storage - Disposition (Continued)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
12.5% Sodium Hypochlorite	10 ppm for chlorine	Not flammable	None listed	Not available	Toxicity Analysis
Hydrogen	Asphyxiant	4.0%-75%	Vapor may explode	29.030 @ -418°F	Toxicity-consider as asphyxiant
					Flammability Analysis
					Explosion Analysis
Monoethanolamine	30 ppm	3.0%-23.5%	None listed	0.4 mm Hg	No further analysis required-low vapor pressure [1]
Nitrogen	Asphyxiant	Not flammable	None listed	65.820 psi @ -294°F	Toxicity-consider as asphyxiant
Liquid Nitrogen	Asphyxiant	Negligible	None listed, if exposed to heat	760 mm Hg @ -196°C	Toxicity-consider as asphyxiant

[1] Chemicals with vapor pressures less than 10 torr, 0.193 psi, were not considered. Chemicals with vapor pressures this low are not very volatile. That is, under normal conditions, chemicals cannot enter the atmosphere fast enough to reach concentrations hazardous to people and, therefore, are not considered to be an air dispersion hazard.

[2] Time-Weighted Average (TWA)

Note: Chemical information was obtained from the CHRIS manual (Reference 2.2S-37), except for Sodium Bromide (Reference 2.2S-52), Sulfuric Acid (Reference 2.2S-39), Fyrquel EHC (Reference 2.2S-38), toxicity limit for Fyrquel EHC as Triphenyl Phosphate (Reference 2.2S-39), vapor pressure value for Gasoline (Reference 2.2S-54), Halon 1301 (Reference 2.2S-39), Monoethanolamine (Reference 2.2S-39), Liquid Nitrogen (Reference 2.2S-40).

Table 2.2S-7 Offsite Chemicals, Disposition - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
OXEA Corporation					
1-Hexene	30 ppm ~~TLV-TWA [6]~~TEEL [3]	1.2% LEL	Vapor may explode	5.990 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
1-Octene	250 (mg/m^3)-TEEL [3]	0.9% LEL	Vapor may explode	0.657 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
2-Hexene	30 ppm TLV-TWA [6]	Flammable	Vapor may explode	310 mmHG @ 38°C	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
2-Methyl Hexanoic Acid	None established	Flammable	Vapor may explode	0.1mm Hg @ 20°C	No further analysis required- low vapor pressure [1]
Acetaldehyde	2000 ppm	4%-60%	Vapor may explode	27.660 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Acetic Acid	50 ppm	4%-19.9%	Vapor may explode	0.597 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Acetone	2500 ppm	2.6%-12.8%	Vapor may explode	7.516 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis

Table 2.2S-7 Offsite Chemicals, Disposition - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy (Continued)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
OXEA Corporation					
Nickel Catalyst	10 mg/m^3	Not Flammable	None Listed	Not available-solid	No further analysis required- low vapor pressure [1]
Cyclohexylamine	30 ppm -TEEL [3]	1.5%-9.4%	Vapor may explode	0.415 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Hydrazine	50 ppm	4.7%-100%	Vapor may explode	0.567 psi @100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
2-(2-Butoxyethoxy)	None established	Not flammable	None listed	12 mm Hg	No further analysis required
Sodium Hypochlorite	10 ppm for chlorine	Not flammable	None listed	Not available	Toxicity Analysis
Aluminum Oxide Catalyst	None established	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]
Iron Oxide Catalyst	2500 mg/m^3	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]
Zinc Oxide Catalyst	500 mg/m^3	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]
Carbon Dioxide	40,000 ppm	Not flammable	None listed	907.299 psi@ 75°F	Toxicity-consider as asphyxiant
Carbon Monoxide	1200 ppm	12-75%	None listed	49.090 psi @ 292°F	Toxicity-consider as asphyxiant
					Flammability Analysis

Table 2.2S-7 Offsite Chemicals, Disposition - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy (Continued)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
OXEA Corporation					
Diatomaceous Earth	3000 mg/m^3	Not flammable	None listed	Not available-solid	No further analysis required
Silver Catalyst	10 mg/m^3	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]
Silica	3000 mg/m^3	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]
Aluminum Silicate	10 mg/m^3-TLV [6]	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]
Diesel	None established	1.3%-6.0% vol.	None listed	0.100 psi @ 100°F	No further analysis required- low vapor pressure [1]
Diisopropanolamine	None established	1.1%-5.4%	None listed	0.001 psi @ 110°F	No further analysis required- low vapor pressure [1]
Dimethyl Sulfide	2000 ppm -TEEL [3]	2.2%-19.7%	Vapor may explode	15.090 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Drewfloc 2449 (33% petroleum distillate)	1000 ppm	0.9%-6.0%	Vapor may explode	0.124 psi @ 100°F	No further analysis required- low vapor pressure [1]
Drewsperse 2625B Antifoulant (Potassium Hydroxide)	None established	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]

Table 2.2S-7 Offsite Chemicals, Disposition - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy (Continued)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
OXEA Corporation					
Ethyl Acetate	2000 ppm	2.2%-9.0%	Vapor may explode	3.186 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Ethylene	15,000 ppm -TEEL [3]	2.75%-28.6%	Vapor may explode	65.099 psi @ 100°F	Toxicity Flammability Analysis Explosion Analysis
Ethylene Glycol	None established	3.2% LEL	None listed	0.005 psi @ 100°F	No further analysis required- low vapor pressure [1]
G-132 D Catalyst (copper oxide catalyst)	100 mg/m^3	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]
G55/G65 Catalyst	None established	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]
Calcium Carbonate	10 mg/m^3-TWA [6]	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]
Gasoline [6]	300 ppm -TWA [6]	1.4%-7.4%	Vapor may explode	292 mm Hg @ 81.4°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Hexanoic Acid	None established	Not flammable	None listed	0.019 psi @ 161°F	No further analysis required- low vapor pressure [1]

Table 2.2S-7 Offsite Chemicals, Disposition - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy (Continued)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
OXEA Corporation					
Hydrogen	Asphyxiant	4.0%-75%	Vapor may explode	29.030 @ -418°F	Toxicity-consider as asphyxiant
					Flammability Analysis
					Explosion Analysis
Hydroquinone	50 mg/m^3	Not flammable	None listed	Not Available-solid	No further analysis required- low vapor pressure [1]
Isobutanol	1600 ppm	1.6%-10.9%	Vapor may explode	0.513 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Isobutyl Acetate	1300 ppm	2.4%-10.5%	Vapor may explode	0.664 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Sulfuric Acid	15 mg/m^3	Not flammable	None listed	0.001 mm Hg	No further analysis required- low vapor pressure [1]
Isobutyraldehyde	1500 ppm -TEEL [3]	2.0%-10%	Vapor may explode	5.666 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Calcium Oxide	25 mg/m^3	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]

Table 2.2S-7 Offsite Chemicals, Disposition - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy (Continued)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
OXEA Corporation					
Methane	25,000 ppm -TEEL [3]	5.0%-15%	Vapor may explode	31.920 psi @ -240°F	Toxicity-consider as asphyxiant
					Flammability Analysis
					Explosion Analysis
Methane Sulfonic Acid	None established	Not flammable	None listed	< 1 mm Hg @ 20°C	No further Analysis
Monoethanolamine	30 ppm	3.0%-23.5%	None listed	0.4 mm Hg	No further analysis required- low vapor pressure [1]
N-Butanol	1400 ppm	1.45%-11.25%	None listed	5.5 mm Hg @25°C	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
N-Butyl Acetate	1700 ppm	1.7%-7.6%	Vapor may explode	0.489 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
N-Butyraldehyde	2000 ppm -TEEL [3]	2.5%-10.6%	Vapor may explode	5.670 psi @ 100F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
N-Heptanal	None established	0.78%-15.25%	None listed	3.52 mm Hg @ 25°C	No further analysis required- low vapor pressure [1]
N-Heptanoic Acid	None established	Not flammable	None listed	0.028 psi @ 180°F	No further analysis required- low vapor pressure [1]

Table 2.2S-7 Offsite Chemicals, Disposition - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy (Continued)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
OXEA Corporation					
N-Nonanal	None established	0.59%-6.54%	None listed	0.2 mm Hg @ 20°C	No further analysis required- low vapor pressure [1]
N-Propyl Acetate	1700 ppm	2.0%-8.0%	Vapor may explode	1.232 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
N-Propyl Alcohol	800 ppm	2.1%-13.5%	Vapor may explode	0.732 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Nitrogen	Asphyxiant	Not flammable	None listed	65.820 psi @ -294°F	Toxicity-consider as asphyxiant
Nonanoic Acid	None established	Not flammable	None listed	1 mm Hg @ 108°C	No further analysis required
Oxygen	None established	Not flammable	None listed	36.260 psi @ -280°F	No further analysis required
Parabenzoquinone	100 mg/m^3	Not flammable	Dust may explode	0.1 mm Hg @ 77°F	No further analysis required- low vapor pressure [1]
Phosphoric Acid	1000 mg/m^3	Not flammable	None listed	0.03 mm Hg @ 20°C	No further analysis required- low vapor pressure [1]
Potassium Acetate	None established	Not flammable	None listed	Not available-solid	No further analysis required
Potassium Hydroxide	None established	Not flammable	None listed	Not available-solid	No further analysis required

Table 2.2S-7 Offsite Chemicals, Disposition - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy (Continued)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
OXEA Corporation					
Propionaldehyde	500 (mg/m^3) -TEEL [3]	2.6%-16.1%	Vapor may explode	10.130 psi@ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Propylene	Asphyxiant	2.0%-11.0%	Vapor may explode	20.600 psi@ -40°F	Toxicity-consider as asphyxiant
					Flammability Analysis
					Explosion Analysis
Propylene Glycol	None established	2.6%-12.5%	None listed	0.005 psi @ 100°F	No further analysis required- low vapor pressure [1]
Sand (silica dust)	30 mg/m^3 -PEL [5]	Not flammable	None listed	10 mm Hg @ 3150°F	No further analysis required- low vapor pressure [1]
Sodium Hydroxide Solution	None established	Not flammable	None listed	13mm Hg @ 140°F	No further analysis required
Sulfolane	None established	Not flammable	None listed	0.038 psi @ 220°F	No further analysis required- low vapor pressure [1]
Lubricating Oil	None established	Not flammable	None listed	0.100 psi @ 100°F	No further analysis required- low vapor pressure [1]
Tripenylphosphine	None established	Not listed	None listed	Not available-solid	No further analysis required- low vapor pressure [1]
Vanadium Pentaoxide	35 mg V/m^3 (dust or fume)	Not flammable	None listed	Not available	No further analysis required

Table 2.2S-7 Offsite Chemicals, Disposition - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy (Continued)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
OXEA Corporation					
Zinc Oxide	500 mg/m^3	Not flammable	None listed	Not available-solid	No further analysis required- low vapor pressure [1]
UCON LB-625 Polyalkylene Glycol	None established	Not listed	None listed	<0.01 mm Hg @ 20°C	No further analysis required- low vapor pressure [1]
Vinyl Acetate	500 ppm -ERPG [7]	2.6%-13.4%	Vapor may explode	3.977 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Gulfstream Terminal and Marketing LLC					
Gasoline [4]	300 ppm -TWA [6]	1.4%-7.4%	Vapor may explode	292 mm Hg @ 81.4°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Diesel Oil	None established	1.3%-6.0% vol.	None listed	0.100 psi @ 100°F	No further analysis required- low vapor pressure [1]

Table 2.2S-7 Offsite Chemicals, Disposition - OXEA Corporation, Gulfstream Terminal and Marketing LLC, and GulfMark Energy (Continued)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
GulfMark Energy					
Crude Petroleum	None Established	Not flammable	Combustible	0.100 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis

[1]Chemicals with vapor pressure less than 10 torr, 0.193 psi, were not considered. Chemicals with vapor pressures this low are not very volatile. That is, under normal conditions, chemicals cannot enter the atmosphere fast enough to reach concentrations hazardous to people and, therefore, are not considered to be an air dispertion hazard.
[2]This is bounded by the onsite storage of liquid nitrogen.
[3]Temporary Emergency Exposure Limit (TEEL)
[4]The gasoline stored at OXEA Corporation and Gulfstream Terminal and Marketing LLC is bounded by the transport of gasoline by barge on the Colorado River due to the quantity of gasoline carried on the barge, 1,680,000 gallons and its proximity, 16,276 feet, to STP 3 & 4.
[5]Permissible Exposure Limit (PEL)
[6]Threshold Limit Value/Time Weighted Average (TLV-TWA)
[7]Emergency Response Planning Guideline (ERPG)

Note: Chemical information was obtained from the CHRIS manual (Reference 2.2S-37); 2-Hexene (Reference 2.2S-40); 2-Hexene assumed same IDLH as 1-Hexene; 2-(2-Butoxyethoxy) (Reference 2.2S-43); vapor pressure of Phosphoric Acid, flammability of Cyclohexylamine, IDLH value of Chlorine, Sulfuric Acid, Monoethanolamine, Parabenzoquinone, nickel catalyst, aluminum oxide, iron oxide, zinc oxide, silver catalyst, silica, and copper oxide (Reference 2.2S-39); sodium hydroxide solution, Tripenylphosphine, Sand, and Diatomaceous Earth (Reference 2.2S-36); Isobutyraldehyde (Reference 2.2S-56); N-Butanol (Reference 2.2S-57); N-Heptanal (Reference 2.2S-44); N-Nonanal (Reference 2.2S-57); Nonanoic Acid (Reference 2.2S-45); Potassium Acetate (Reference 2.2S-52); Polyalkylene Glycol (Reference 2.2S-46); Aluminum Silicate (Reference 2.2S-59); 2-Methyl Hexanoic Acid (Reference 2.2S-66); methane sulfonic acid (Reference 2.2S-67); and toxicity of dimethlyl sulfide, ethylene, isobutyraldehyde, methane, N-butyraldehyde, propionaldehyde, and Vinyl Acetate (Reference 2.2S-48).

Table 2.2S-8 Hazardous Materials, Navigable Waterway Transportation - Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard ?	Vapor Pressure	Disposition
Crude Petroleum	None established	Not flammable	None listed	0.100 psi @ 100°F	No further analysis required- low vapor pressure [1]
Residual Fuel Oil (#6)	None established	1%-5%	None listed	0.100 psi @ 100°F	No further analysis required- low vapor pressure [1]
N-Butanol	1400 ppm	1.45%-11.25%	None listed	5.5 mm Hg @ 25°C	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Isobutanol	1600 ppm	1.6%-10.9%	Vapor may explode	0.513 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Acetic Acid	50 ppm	4%-19.9%	Vapor may explode	0.597 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
N-Butyl Acetate	1700 ppm	1.7%-7.6%	Vapor may explode	0.489 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Vinyl Acetate	500 ppm [2]	2.6%-13.4%	Vapor may explode	3.977 psi @ 100°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis

Table 2.2S-8 Hazardous Materials, Navigable Waterway Transportation - Disposition (Continued)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard ?	Vapor Pressure	Disposition
Gasoline	300 ppm- TWA [3]	1.4%-7.4%	Vapor may explode	292 mm Hg @ 81.4°F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis

[1] Chemicals with vapor pressures less than 10 torr, 0.193 psi, were not considered. Chemicals with vapor pressures this low are not very volatile. That is, under normal conditions, chemicals cannot enter the atmosphere fast enough to reach concentrations hazardous to people and, therefore, are not considered to be an air dispersion hazard.

[2] Emergency Response Planning Guidelines (ERPGs)--The ERPGs were developed by the ERPG committee of the American Industrial Hygiene Association. The ERPGs were developed as planning guidelines, to anticipate human adverse health effects caused by exposure to toxic chemicals. The ERPGs are three-tiered guidelines with one common denominator: a 1-hour contact duration. The selected ERPG is defined as the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

[3] Time Weighted Average (TWA)

Note: Chemical information was obtained from the CHRIS manual (Reference 2.2S-37), except for N-Butanol (Reference 2.2S-57), vapor pressure of gasoline (Reference 2.2S-54), and vinyl acetate (References 2.2S-44 and 2.2S-48).

Table 2.2S-9 Design-Basis Events - Explosions

Source	Pollutant Evaluated	Quantity	Heat of Combustion (Btu/lb)	Distance to Nearest Safety-Related Structure	Distance for Explosion to have less than 1 psi of Peak Incident Pressure
FM 521	Gasoline	9,000 gal	18,720 Btu/lb	2700 ft	266 ft
Pipeline: Dow Pipeline Company	Natural Gas	2,218,242 lbs (entire mass of a 10 minute release)	21,517 Btu/lb	10,000 ft	7,577 ft
Navigable Waterway (Colorado River)	n-Butanol	380,000 gal	14,230 Btu/lb	15,974 ft	896 ft
	Isobutanol	380,000 gal	14,220 Btu/lb		888 ft
	Acetic Acid	500,000 gal	5,645 Btu/lb		814 ft
	n-Butyl Acetate	380,000 gal	13,130 Btu/lb		885 ft
	Vinyl Acetate	380,000 gal	9,754 Btu/lb		880 ft
	Gasoline	40,000 BBLs or 1,680,000 gal	18,720 Btu/lb		1,517 ft
Onsite (Includes STP 1 & 2)	Gasoline (12,000 gallon above ground storage tank)	12,000 gal	18,720 Btu/lb	1,771 ft	296 ft
	Hydrazine	1,260 lbs	8,345 Btu/lb	2,518 ft	86 ft
	Hydrogen	100,200 ft^3	50,080 Btu/lb	1,563 ft	1,048 ft

Table 2.2S-9 Design-Basis Events - Explosions (Continued)

Source	Pollutant Evaluated	Quantity	Heat of Combustion (Btu/lb)	Distance to Nearest Safety-Related Structure	Distance for Explosion to have less than 1 psi of Peak Incident Pressure
Offsite (OXEA Corp.)	1-Hexene	1,265,000 lbs	19,134 Btu/lb	22,841 ft	734 ft
	1-Octene	2,010,000 lbs	19,170 Btu/lb		766 ft
	2-Hexene	3,861 lbs	19,134 Btu/lb		108 ft
	Acetaldehyde	866,295 lbs	10,600 Btu/lb		835 ft
	Acetic Acid	9,999,999 lbs	5,645 Btu/lb		1,072 ft
	Acetone	4,400 lbs.	12,250 Btu/lb		99 ft
	Cyclohexylamine	4,000 lbs	18,000 Btu/lb		114 ft
	Hydrazine	4,000 lbs	8,345 Btu/lb		126 ft
	Dimethyl Sulfide	10,000 lbs	13,200 Btu/lb		154 ft
	Ethyl Acetate	21,800 lbs	10,110 Btu/lb		154 ft
	1-Hexene	1,265,000 lbs	19,134 Btu/lb		734 ft
	Ethylene	470,000 lbs	20,290 Btu/lb		7,575 ft
	Hydrogen	58,512 lbs	50,080 Btu/lb		5,111 ft
	Isobutanol	3,455,333 lbs	14,220 Btu/lb		984 ft
	Isobutyl Acetate	9,999,999 lbs	13,000 Btu/lb		1,509 ft
	Isobutyraldehyde	999,999 lbs	13,850 Btu/lb		622 ft
	Methane	47,000 lbs	21,517 Btu/lb		3,586 ft
	n-Butanol	16,921,268 lbs.	14,230 Btu/lb		1,681 ft
	n-Butyl Acetate	9,999,999 lbs.	13,130 Btu/lb		1,358 ft
	n-Butyraldehyde	3,300,000 lbs.	15,210 Btu/lb		969 ft
	n-Propyl Acetate	9,999,999 lbs	9, 420 Btu/lb		1,178 ft
	Ethylene	470,000 lbs	20,290 Btu/lb		7,575 ft
	n-Propyl Alcohol	9,999,999 lbs	13,130 Btu/lb		1,365 ft
	Propionaldehyde	600,000 lbs	12,470 Btu/lb		548 ft
	Propylene	740,000 lbs	19,692 Btu/lb		8,724 ft
	Vinyl Acetate	3,700,000 lbs	9,754 Btu/lb		948 ft
Offsite (GulfMark)	Crude Petroleum	1,050,000 gal	18,252 Btu/lb	24,244 ft	1,124 ft

Table 2.2S-10 Design-Basis Events, Flammable Vapor Clouds (Delayed Ignition) and Vapor Cloud Explosions

Source	Pollutant Evaluated & Quantity	Distance to Nearest Safety-Related Structure	Distance to UFL	Distance to LFL	Safe Distance for Vapor Cloud Explosions	Peak Overpressure at Nearest Safety-Related Structure (psi)
FM 521	Gasoline (9,000 gal)	2700 ft	243 ft	408 ft	1,035 ft	0.379 psi
Pipeline: Dow Pipeline Company	Natural Gas	10,000 ft	Not provided [1]	492 ft	1,494 ft	Not provided [1]
Waterway (Colorado River)	n-Butanol (380,000 gal)	15,974 ft	432 ft	801 ft	1,593 ft	No significant overpressure
	Isobutanol (380,000 gal)		507 ft	918 ft	1,848 ft	No significant overpressure
	Acetic Acid (500,000 gal)		Never exceeded	Never exceeded	No explosion	No explosion
	n-Butyl Acetate (380,000 gal)		606 ft	975 ft	1,974 ft	No significant overpressure
	Vinyl Acetate (380,000 gal)		795	1,812 ft	3,570 ft	0.119 psi
	Gasoline (1,680,000 gal)		4,554 ft	5,605 ft	8,642 ft	Not available
Onsite (Includes STP 1 & 2)	Gasoline (12,000 gallon above ground storage tank)	1,771 ft	285 ft	480 ft	1,200 ft	0.537 psi
	Hydrazine (150 gal)	2,518 ft	<33 ft	<33 ft	No explosion	No explosion
	Hydrogen (80,000 ft^3)	1,563 ft	300 ft	1,362 ft	1,557 ft	0.987 psi
	Monoethanolamine (15,000 gal)	1,807 ft	141 ft	138 ft	No explosion	No explosion

Table 2.2S-10 Design-Basis Events, Flammable Vapor Clouds (Delayed Ignition) and Vapor Cloud Explosions (Continued)

Source	Pollutant Evaluated & Quantity	Distance to Nearest Safety-Related Structure	Distance to UFL	Distance to LFL	Safe Distance for Vapor Cloud Explosions	Peak Overpressure at Nearest Safety-Related Structure (psi)
Offsite (OXEA Corp.)	1-Hexene (1,265,000 lbs)	22,841 ft	~~1,209~~240 ft	~~2,805~~423 ft	~~5,280~~948 ft	~~0.129 psi~~No significant overpressure
	1-Octene (2,010,000 lbs)		546 ft	1,059 ft	2,142 ft	No significant overpressure
	2-Hexene (3,861 lbs)		111 ft	201 ft	507 ft	No significant overpressure
	Acetaldehyde (866,300 lbs)		360 ft	3,012 ft	5,808 ft	0.161 psi
	Acetic Acid (9,999,999 lbs)		Never exceeded	Never exceeded	No explosion	No explosion
	Acetone (4,400 lbs)		78 ft	150 ft	387 ft	No significant overpressure
	Cyclohexylamine (4,000 lbs)		Never exceeded	<33 ft	66 ft	No significant overpressure
	Hydrazine (4,000 lbs)		<33 ft	<33 ft	No explosion	No explosion
	Carbon Monoxide (868,000 lbs)		3,780 ft	7,920 ft	10,032 ft	0.186 psi
	Dimethyl Sulfide (10,000 lbs)		180 ft	399 ft	891 ft	No significant overpressure
	Ethyl Acetate (21,800 lbs)		159 ft	258 ft	600 ft	No significant overpressure
	Ethylene (470,000 lbs)		4,146 ft	12,672 ft	14,784 ft	0.315 psi
	Hydrogen (58,512 lbs)		3,651 ft	12,672 ft	14,256 ft	0.200 psi
	Isobutanol (3,455,333 lbs)		Never exceeded	186 ft	537 ft	No significant overpressure
	Isobutyl Acetate (9,999,999 lbs)		468 ft	843 ft	1,698 ft	No significant overpressure

Table 2.2S-10 Design-Basis Events, Flammable Vapor Clouds (Delayed Ignition) and Vapor Cloud Explosions (Continued)

Source	Pollutant Evaluated & Quantity	Distance to Nearest Safety-Related Structure	Distance to UFL	Distance to LFL	Safe Distance for Vapor Cloud Explosions	Peak Overpressure at Nearest Safety-Related Structure (psi)
Offsite (OXEA Corp.)	Isobutyraldehyde (999,999 lbs)	22,841 ft	909 ft	2,241 ft	4,224 ft	No significant overpressure
	Methane (47,000 lbs)		2,565 ft	4,614 ft	5,808 ft	No significant overpressure
	n-Butanol (16,921,268 lbs)		Never exceeded	Never exceeded	No explosion	No explosion
	n-Butyl Acetate (9,999,999 lbs)		429 ft	618 ft	1,269 ft	No significant overpressure
	n-Butyraldehyde (3,300,000 lbs)		756 ft	1,560 ft	3,234 ft	No significant overpressure
	n-Heptanal (325,000 lbs)		Never exceeded	Never exceeded	No explosion	No explosion
	n-Propyl Acetate (9,999,999 lbs)		612 ft	966 ft	1,938 ft	No significant overpressure
	Hydrogen (58,512 lbs)		3,651 ft	12,672 ft	14,256 ft	0.200 psi
	n-Propyl Alcohol (9,999,999 lbs)		396 ft	687 ft	1,383 ft	No significant overpressure
	Propionaldehyde (600,000 lbs)		822 ft	2,415 ft	4,725 ft	0.112 psi
	Propylene (740,000 lbs)		546 ft	2,694 ft	7,920 ft	0.238 psi
	Vinyl Acetate (3,700,000 lbs)		741 ft	1,575 ft	3,138 ft	No significant overpressure

Table 2.2S-10 Design-Basis Events, Flammable Vapor Clouds (Delayed Ignition) and Vapor Cloud Explosions (Continued)

Source	Pollutant Evaluated & Quantity	Distance to Nearest Safety-Related Structure	Distance to UFL	Distance to LFL	Safe Distance for Vapor Cloud Explosions	Peak Overpressure at Nearest Safety-Related Structure (psi)
Offsite (GulfMark)	Crude Petroleum (1,050,000 gal)	24,244 ft			The evaporation rate of crude petroleum is so low that a vapor cloud of substantial concentration is never reached.	

[1] Not provided-A calculation was performed to determine concentrations outside the control room intake and distances to the LFL, rather than the ALOHA model. Because, the toxic concentrations had dissipated below the toxicity limit prior to reaching the control room intake, calculating the concentration inside the control room was not required. Further, the LFL distance was the reported distance for this calculation as this distance is greater than the UFL.

Table 2.2S-11 Design-Basis Events, Toxic Vapor Clouds

Source	Chemical	Quantity	IDLH	Distance to STP 3 & 4 Control Room	Distance to IDLH	Maximum Control Room Concentration
FM 521	Gasoline	9,000 gal	300 ppm TWA /500 ppm STEL	2,853 ft	2,034 ft	22.9 ppm
Waterway (Colorado River)	n-Butanol	380,000 gal	1,400 ppm	15,974 ft	1,974 ft	>1 hr [3]
	Isobutanol	380,000 gal	1,600 ppm		2,292 ft	> 1 hr [3]
	Acetic Acid	500,000 gal	50 ppm		10,032 ft	>1 hr [3]
	n-Butyl Acetate	380,000 gal	1,700 ppm		2,205 ft	> 1 hr [3]
	Vinyl Acetate	380,000 gal	500 ppm		10,032 ft	>1 hr [3]
	Gasoline	1,680,000 gal	300 ppm TWA /500 ppm STEL		9,843 ft	Not applicable [4]
Onsite (Includes STP 1 & 2)	Freon-11	2,917 lbs	2,000 ppm	1,755 ft	651 ft	34.8 ppm
	Freon-12	55,200 lbs	15,000 ppm	1,755 ft	1,521 ft	653 ppm
	Gasoline	12,000 gal	300 ppm TWA /500 ppm STEL	1,976 ft	2,388 ft	110 ppm
	Halon 1301	9,150 lbs	40,000 ppm	2,032 ft	522 ft	154 ppm
	Hydrogen	80,000 ft^3	Asphyxiant	1,668 ft	Not applicable [5]	1,490 ppm
	Sodium Hypochlorite	7,200 gal	10 ppm as Chlorine	2,559 ft	177 ft	0.045 ppm
	Monoethanolamine	15,100 gal	30 ppm	1,961 ft	867 ft	4.31 ppm
	Hydrazine	150 gal	50 ppm	2,671 ft	843 ft	1.84 ppm
	Nitrogen	20,000 lbs	Asphyxiant	1,613 ft	Not applicable [5]	5,540 ppm
	Liquid Nitrogen	92,400 lbs	Asphyxiant	1,613 ft	Not applicable [5]	1,390 ppm

Table 2.2S-11 Design-Basis Events, Toxic Vapor Clouds (Continued)

Source	Chemical	Quantity	IDLH	Distance to STP 3 & 4 Control Room	Distance to IDLH	Maximum Control Room Concentration
Offsite (OXEA Corp.)	1-Hexene	1,265,000 lbs	30 ppm [1]	22,841 ft	~~>31,680~~6,864 ft ~~[6]~~	>1 hr [3]
	1-Octene	2,010,000 lb	250 mg/m^3		8,976 ft	>1 hr [3]
	2-Hexene	3,861 lb	30 ppm		3,645 ft	>1 hr [3]
	Acetaldehyde	866,300 lbs	2,000 ppm		13,200 ft	>1 hr [3]
	Acetic Acid	9,999,999 lbs	50 ppm		9,504 ft	>1 hr [3]
	Acetone	4,400 lbs	2,500 ppm		399 ft	> 1 hr [3]
	Cyclohexylamine	4,000 lbs	30 ppm [1]		921 ft	>1 hr [3]
	Dimethyl Sulfide	10,000 lbs	2,000 ppm		1,083 ft	> 1 hr [3]
	Hydrazine	4,000 lbs	50 ppm		1,500 ft	>1 hr [3]
	Sodium Hypochlorite	30,000 lbs	10 ppm		114 ft	>1 hr [3]
	Carbon Dioxide	868,000 lbs	40,000 ppm		7,920 ft	>1 hr [3]
	Carbon Monoxide	868,000 lbs	1,200 ppm		~~>31,680~~10,660 ft [6]	~~>1 hr~~ [~~3~~6]
	Ethyl Acetate	21,800 lbs	2,000 ppm		672 ft	>1 hr [3]
	Ethylene	470,000 lbs	15,000 ppm		11,616 ft	> 1 hr [3]
	Hydrogen	58,512 lbs	Asphyxiant		Not applicable [5]	> 1 hr [3]
	Isobutanol	3,455,333 lbs	1,600 ppm		1,377 ft	>1 hr [3]
	Isobutyl Acetate	9,999,999 lbs	1,300 ppm		1,956 ft	> 1 hr [3]
	Isobutyraldehyde	1,000,000 lbs	1,500 ppm [1]		6,336 ft	>1 hr [3]
	Methane	47,000 lbs	25,000 ppm [1]		4,392 ft	>1 hr [3]
	n-Butanol	16,921,268 lbs	1,400 ppm		777 ft	>1 hr [3]
	n-Butyl Acetate	9,999,999 lbs	1,700 ppm		1,380 ft	>1 hr [3]
	n-Butyraldehyde	3,300,000 lbs	2,000 ppm [1]		4,563 ft	>1 hr [3]

Table 2.2S-11 Design-Basis Events, Toxic Vapor Clouds (Continued)

Source	Chemical	Quantity	IDLH	Distance to STP 3 & 4 Control Room	Distance to IDLH	Maximum Control Room Concentration
Offsite (OXEA Corp.)	n-Propyl Acetate	9,999,999 lbs	1,700 ppm	22,841 ft	2,451 ft	> 1 hr [3]
	n-Propyl Alcohol	9,999,999 lbs	800 ppm		2,637 ft	> 1 hr [3]
	Propionaldehyde	600,000 lbs	500 mg/m^3		21,120 ft	> 1 hr [3]
	Nitrogen	9,999,999 lbs	Asphyxiant		Not applicable [5]	> 1 hr [3]
	Propylene	740,000 lbs	Asphyxiant		Not applicable [5]	> 1 hr [3]
	Vinyl Acetate	3,700,000 lbs	500 ppm [2]		8,448 ft	>1 hr [3]
Offsite (GulfMark)	Crude Petroleum	1,050,000 gal	The evaporation rate of crude petroleum is so low that a vapor cloud of substantial concentration is never reached.	24,244 ft	N/A- The evaporation rate of crude petroleum is so low that a vapor cloud of substantial concentration is never reached.	N/A- The evaporation rate of crude petroleum is so low that a vapor cloud of substantial concentration is never reached.

[1]Temporary Emergency Exposure Limits (TEEL).
[2]Emergency Response Planning Guideline (ERPG).
[3]ALOHA does not report values after 1 hour because it assumes that the weather conditions or other release circumstances are likely to change after an hour.
[4]Not applicable-The TOXDISP model was used to determine concentrations outside the control room intake. Because, the toxic concentrations had dissipated below the toxicity limit prior to reaching the control room intake, calculating the concentration inside the control room was not required.
[5]Not applicable-the material is an asphyxiant with no associated toxicity limit.
[6]~~The control room is greater than 1 hour downwind from the release, the model assumes, with the conservative meteorological conditions applied, that the weather conditions or other circumstances are likely to change such that the vapor cloud would not pose a threat inside the control room.~~The FLACS model was used to determine that the carbon monoxide plume travels to a maximum horizontal distance of 10,660 ft and rises vertically to 4,100 ft before concentrations are lowered to less than IDLH values.

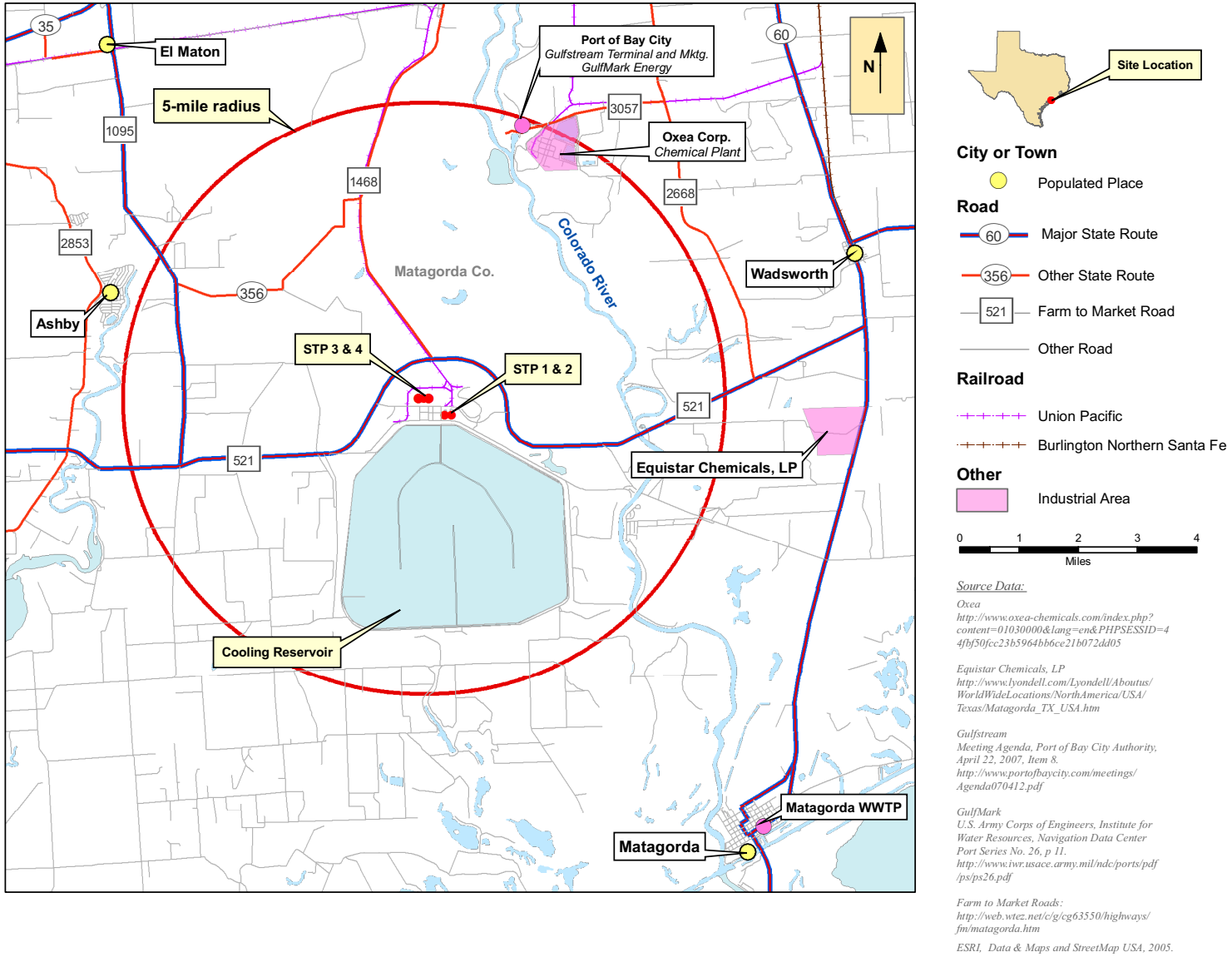


Figure 2.2S-1 Site Vicinity Map

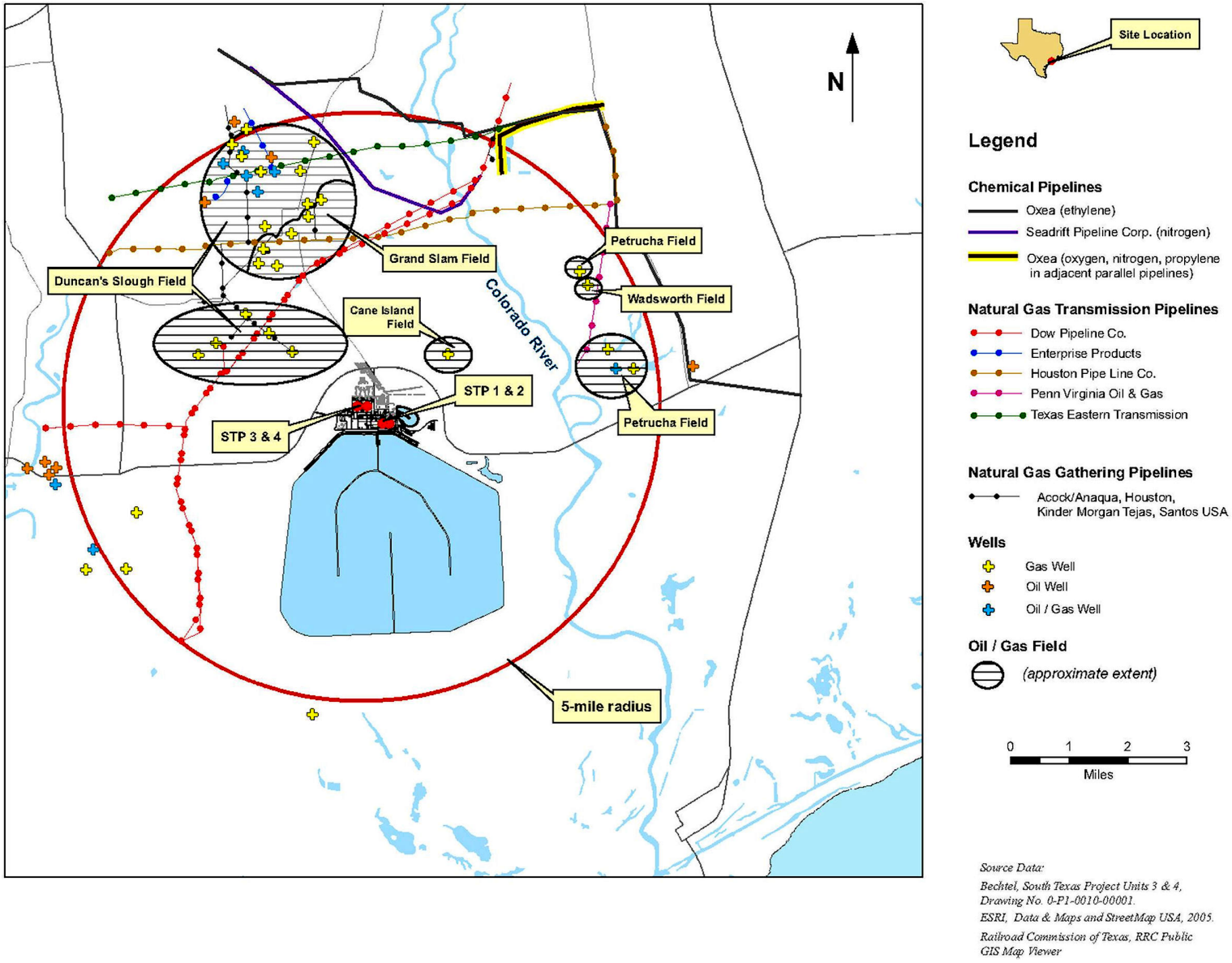
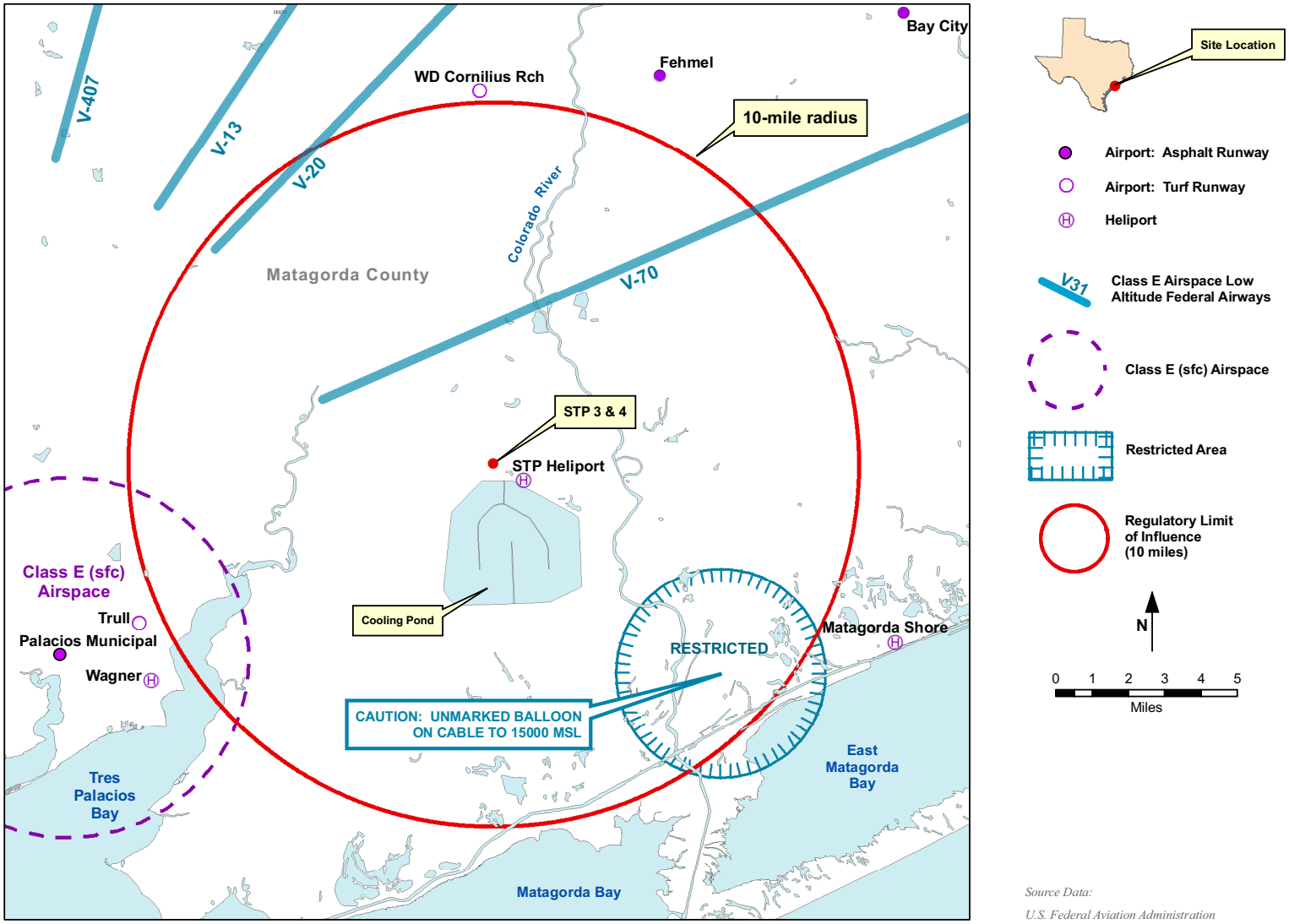


Figure 2.2S-2 Pipeline and Oil/Gas Well Map



Source Data:

U.S. Federal Aviation Administration Sectional Aeronautical Chart, 1:500,000 Houston South, 77th Edition, March 16, 2006

ESRI, Data & Maps and StreetMap USA, 2005.

Figure 2.2S-3 Airport/Airways Map

2.2SA Explosion Methodology

Regulatory Guide 1.206 requires COL applicants to determine on the basis of the information provided in the FSAR Sections 2.2.1 and 2.2.2 the potential accidents to be considered as design-basis events and to identify the potential effects of those accidents on the nuclear plant in terms of design parameters (e.g., overpressure) or physical phenomena (e.g., concentration of flammable or toxic cloud outside building structures). 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; and 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. One of the accident categories considered in selecting design-basis events is explosions. Accidents involving detonations of high explosives, munitions, chemicals, or liquid and gaseous fuels for facilities and activities in the vicinity of the plant or on-site, where such materials are processed, stored, used, or transported in quantity are considered.

An explosion is defined as a sudden and violent release of high-pressure gases into the environment. The release must be sufficiently fast so that energy contained in the high-pressure gas dissipates in a shock wave. (Reference 2.2SA-6) The strength of the wave is measured in terms of overpressures (maximum pressure in the wave in excess of normal atmospheric pressure). Explosions come in the form of detonations or deflagrations. A detonation is the propagation of a combustion zone at a velocity that is greater than the speed of sound in the un-reacted medium. A deflagration is the propagation of a combustion zone at a velocity that is less than the speed of sound in the un-reacted medium. (Reference 2.2SA-4) For an explosion to occur, the following elements must exist simultaneously:

- a flammable mixture (components are thoroughly mixed and are present at a concentration that falls within a flammable composition boundary) consisting of a fuel and oxygen, usually air, or other oxidant
- a means of ignition
- an enclosure or confinement (Reference 2.2SA-6)

Whether an explosion is possible depends in large measure on the physical state of a chemical. In the case of liquids, flammable and combustible liquids often appear to ignite as liquids. However, it is actually the vapors above the liquid source that ignite. (Reference 2.2SA-5, 5.1.2.1.1) For flammable liquids at atmospheric pressure, an explosion will occur only if the non-oxidized, energized fluid is in the gas or vapor form at correct concentrations in air. Physical explosions may also occur with super-heated liquids that flash-evaporate upon the sudden release of the liquid. (Reference 2.2SA-6) The concentrations of formed vapors or gases have an upper and lower bound known as the upper flammable limit (UFL) and the lower flammable limit (LFL). Below the LFL, the percentage volume of fuel is too low to sustain propagation. Above the UFL, the percentage volume of oxygen is too low to sustain propagation. (Reference 2.2SA-5, 5.1.2.2.4)

Two explosion scenarios are evaluated for each flammable chemical capable of sustaining an explosion. The first scenario involves the rupture of a vessel whereby the entire contents of the vessel are released and an immediate deflagration/detonation ensues. That is, upon immediate release, the contents of the vessel are assumed to be capable of supporting an explosion upon detonation (i.e., flammable liquids are present in the gas/vapor phase between the UFL and LFL). The second scenario involves the release of the entire contents of the vessel whereby the gas (or vapors formed from a liquid spill) travel toward the nearest safety-related system, structure, or component and mix sufficiently with oxygen for the vapor cloud to reach concentrations between the UFL and LFL creating the conditions necessary for a vapor cloud explosion whereby detonation occurs. The methodology presented below is representative of the first scenario. (A separate methodology using the Areal Locations of Hazardous Atmospheres (ALOHA) model is used for the second scenario.).

2.2SA.1 Methodology for Explosion (TNT Equivalence Calculation-Scenario 1)

An explanation of the methodology developed is broken up into three sections based on the phase of the chemical during storage/transportation: atmospheric liquids; liquefied gases; and gases.

2.2SA.1.1 Atmospheric liquids

For atmospheric liquids, the allowable and actual distances of hazardous chemicals transported or stored were determined in accordance with RG 1.91, Revision 1. (Reference 2.2SA-7) Regulatory Guide 1.91 cites 1 psi (6.9 kPa) as a conservative value of positive incident over pressure below which no significant damage would be expected. Regulatory Guide 1.91 defines this safe distance by the Hopkinson Scaling Law Relationship:

$$R \geq kW^{1/3}$$

Where R is the distance in feet from an exploding charge of W pounds of equivalent TNT and k is the scaled ground distance constant at a given overpressure (for 1 psi, the value of the constant k is 45 feet/lbs^3). (Reference 2.2SA-7)

In the case of atmospheric liquids, where only that portion in the vapor phase between the UFL and LFL is available to sustain an explosion, the guidance for determining the TNT equivalent, W, in RG 1.91 is not appropriate. That is, when determining the equivalent mass of TNT available for detonation, the mass of a chemical in the vapor phase cannot occupy the same volume under atmospheric conditions as the same mass of the chemical in its liquid phase. Further, upon release of the full contents of a vessel filled with liquid, vaporization of the total mass of the liquid release would not occur instantaneously in the case of liquids stored at atmospheric pressure or below their boiling points. During this phase change, dispersion and mixing would occur—the ALOHA dispersion model is used to model this phenomenon (Scenario 2). Therefore, the methodology employed considers the maximum gas or vapor within the storage as explosive. Thus, for atmospheric liquid storage, this maximum gas or vapor would involve the container to be completely empty of liquid and filled only with air and

fuel vapor at UFL conditions per NUREG-1805. (Note, Scenario 2 conservatively assumes that the entire contents of the vessel are spilled in a 1cm thick puddle under very stable atmospheric conditions to maximize volatilization—a vapor cloud explosion is then modeled using the ALOHA model)

Therefore, for atmospheric liquids, the TNT mass equivalent, W, was determined following guidance in NUREG-1805, where

$$W = (M_{vapor} * \Delta H_c * Y_f)/2000$$

Where M_{vapor} is the flammable vapor mass (lbs), ΔH_c is the heat of combustion (Btu/lb), and Y_f is the explosion yield factor.

2.2SA.1.1.2 Example of Atmospheric Liquid and Vapor Mass Calculation—Gasoline

Chemical Properties of Automotive Gasoline (Reference 2.2SA-1)

Lower Flammability Limit	1.4%
Upper Flammability Limit	7.4%
Vapor Specific Gravity	3.4

To determine the flammable mass:

V_{vap} = Vvessel * UFL

Where:
V_{vap}= flammable vapor volume at UFL, ft^3
Vvessel = liquid (tank) volume, ft^3
UFL= upper flammability limit

$\rho_{vap} = \rho_{air} * SG_{vap}$

Where:
ρ_{air}=air density, lb/ft^3 ($0.074\ lb/ft^3$) (Reference 2.2SA-2)
ρ_{vap}=vapor density, lb/ft^3
SG_{vap}=vapor specific gravity

$M_{vap} = V_{vap} * \rho_{vap}$

Where:
M_{vap}= flammable vapor mass, lbs

And:
Vvessel= 9,000 gal = 9,000gal * $0.13368\ ft^3/gal$ = $1,203.12\ ft^3$
V_{vap}= $1,203.12\ ft^3$ * 7.4%= $89.0309\ ft^3$

ρ_{vap}= ($0.074\ lb/ft^3$) * 3.4 = $0.2516\ lb/ft^3$

M_{vap}= $89.03\ ft^3$ * $0.2516\ lb/ft^3$ = 22 lbs.

Therefore:
W_{TNT}=(22 * 18,720 * 100%) / 2,000 (Reference 2.2SA-6)

(Note: A 100% yield factor will be attributed to the explosion—this is very conservative because 100% yield cannot be achieved) (Reference 2.2SA-3)

W=205.92 lbs

$R \geq kW^{1/3}$ (Reference 2.2SA-7)

$R \geq 45\ (206)^{1/3}$

R≥ 266 ft

2.2SA.1.2 Liquefied Gases

For liquefied gases, the entire mass is considered as a flammable gas/vapor because a sudden tank rupture would entail the release of a majority of the contents in the vapor/aerosol form and a confined explosion could possibly ensue (i.e., the liquid would violently expand and mix with air while changing states from the liquid phase to a vapor/aerosol phase).

Again, for liquefied gases, the allowable and actual distances of hazardous chemicals transported or stored were determined in accordance with NRC Regulatory Guide 1.91.

In this case the entire mass is conservatively considered available for detonation, the equivalent mass of TNT, W, is calculated as follows:

W=E/2000 lb (NUREG-1805, where E is the blast wave energy)

$E= M_{flammable} * \Delta H_c * Y_f$ (NUREG-1805, where Y_f is the explosion yield factor)

2.2SA.1.2.1 Example of Liquefied Gases Calculation--Ethylene:

- Quantity: 470,000 lb
- Flammable mass ($M_{flammable}$): 470,000 lb
- Heat of combustion (ΔH_c) (Btu/lb): 20,290 (Reference 2.2SA-1)

  E=(470,000 lbs) * (20,290) *(100%) (Reference 2.2SA-6)
  E= 9.54E9

  W= (9.54E9) / 2000
  W=4.76815E6 lbs.

  R≥ 7,574.1 ft

2.2SA.1.3 Gases

For pressurized gases, the allowable and actual distances of hazardous chemicals transported or stored were determined in accordance with RG 1.91.

As in the evaluation of liquefied gases, the entire mass is conservatively considered as a flammable gas and available for detonation because a sudden tank rupture would entail the rapid release of a majority of the contents in the vapor/gas phase and a confined explosion could possibly ensue. Therefore, the M_{TNT}, is calculated as follows:

$W=E/2000$ (NUREG-1805, where E is the blast wave energy)
$E= M_{flammable} * \Delta H_c * Y_f$ (NUREG-1805, where Y_f is the explosion yield factor)

2.2SA.1.3.1 Example of Pressurized Gas—Hydrogen:

- Quantity: 100,200 ft^3
- Vapor Specific Gravity: 0.067 (Reference 2.2SA-1)
- Heat of Combustion: 50,080 Btu/lb (Reference 2.2SA-1)

$\rho_{vap}=\rho_{air} * SG_{vap}$

Where:
ρ_{air}=air density, lb/ft^3 (0.074 lb/ft^3) (Reference 2.2SA-2)
ρ_{vap}=vapor density, lb/ft^3
SG_{vap}=vapor specific gravity

$M_{vap}=V_{vap} * \rho_{vap}$

Where:
M_{vap}= flammable vapor mass, lbs

ρ_{vap}= (0.074 lb/ft^3) * 0.067= 0.004958 lb/ft^3

M_{vap}= 100,200 ft^3 * 0.005 lb/ft^3= 503.51 lb

W= (503.51lb * 50,080 Btu/lb) / (2,000 Btu/lb) = 12,607.77 lbs

$R \geq 45 * (12{,}607.77)^{1/3} = 1{,}047.35$ ft

2.2SA.2 References

2.2SA-1 Chemical Hazards Response Information System (CHRIS), United States Coast Guard, November 1998.

2.2SA-2 "Flow of Fluids through Valves, Fittings and Pipes." Crane Valves North America. 1988.

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