SECTION 2.2:
NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES
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2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

PTN COL 2.2-1

The purpose of this section is to establish whether the effects of potential accidents onsite 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. Facilities and activities within the vicinity, 5 miles, of Turkey Point Units 6 & 7 were considered to meet the guidance in RG 1.206. Facilities and activities at greater distances are included as appropriate to their significance.

STD DEP 1.1-1

Subsection 2.2.1 of the DCD is renumbered as Subsection 2.2.4 and moved to the end of Section 2.2. This is being done to accommodate the incorporation of RG 1.206 numbering conventions for Section 2.2.

2.2.1 LOCATIONS AND ROUTES

PTN COL 2.2-1
PTN COL 3.5-1
PTN COL 3.3-1

Potential hazard facilities and routes within the vicinity (5 miles) of Units 6 & 7, and airports within 10 miles of Units 6 & 7 are 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 within 5 miles of Units 6 & 7 concluded there is one significant industrial facility associated with a military installation identified for further analysis. An evaluation of major transportation routes within the vicinity of Units 6 & 7 identified one natural gas transmission pipeline system and one navigable waterway for assessment (References 204, 206, 207, and 208).

Potential hazard analysis of internal events includes Units 1 through 5 and onsite chemical and chemical storage facilities associated with Units 6 & 7 along with an onsite transportation route.

A site vicinity map (Figure 2.2-201) details the following identified facilities and road and waterway transportation routes:

Significant Industrial and Military Facilities Within 5 Miles

- Turkey Point Units 1 through 5
- Homestead Air Reserve Base

Transportation Routes Within 5 Miles

- Onsite transportation route
- Miami to Key West, Florida Intracoastal Waterway
- Florida Gas Transmission Company, Turkey Point Lateral Pipeline and Homestead Lateral Pipeline

An evaluation of nearby facilities and transportation routes within 10 miles of Units 6 & 7 revealed that there are no additional facilities significant enough to be identified as potential hazard facilities. (References 207, 224, and 225)

Potential hazard analyses of airports within 10 miles of Units 6 & 7 are identified along with airway and military operation areas. There are two airports within 10 miles of the plant and one airway identified whose centerline is located approximately 5.98 miles from the plant identified for further analysis. (References 209, 210, 223, and 240)

Figure 2.2-202 illustrates the following identified airports and airway routes within 10 miles of Units 6 & 7, including:

Airport and Airway Routes Within 10 Miles

- Turkey Point Heliport
- Homestead Air Reserve Base
- Ocean Reef Club Airport
- Airway V-3

There are no identified hazard facilities, routes, or activities greater than 10 miles that are significant enough to be identified (References 207, 223, 224, 225, and 240).

Items illustrated in Figures 2.2-201 and 2.2-202 are described in Subsection 2.2.2.

2.2.2 DESCRIPTIONS

Descriptions of the industrial, transportation, and military facilities located in the vicinity of Units 6 & 7 and identified in Subsection 2.2.1 are provided in the subsequent subsections in accordance with RG 1.206.

2.2.2.1 Description of Facilities

In accordance with RG 1.206, two facilities, along with the onsite chemical and chemical storage facilities associated with Units 6 & 7, were identified for review:

- Turkey Point Units 1 through 5
- Homestead Air Reserve Base

Table 2.2-201 provides a concise description of each facility, including its primary function and major products, as well as the number of people employed.

2.2.2.2 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. In accordance with RG 1.206, chemicals stored or situated at distances greater than 5 miles from the plant do not need to be considered unless they have been determined to have a significant impact on the proposed facilities.

The South Florida Regional Planning Council, Emergency Management Division, was contacted to obtain information regarding offsite chemical storage. The EPA's Envirofacts/Enviromapper database was also queried to ascertain if other facilities of significance existed in addition to the facilities identified after evaluating the Superfund Amendments and Reauthorization Act (SARA) Title III, Tier II reports obtained from South Florida Regional Planning Council. Other than the Turkey Point Units 1 through 5 site, there was only one identified external facility, Homestead Air Reserve Base, within 5 miles of the Turkey Point site with

hazardous material storage in quantities identified as meeting SARA Title III Tier II reporting requirements. A review of SARA reports encompassing an area extending out from Units 6 & 7 with a minimum radius of 7.24 miles out to a maximum radius of 28.45 miles inclusive of the following zip codes: 33035, 33033, 33032, 33039, and 33037 revealed that there are no other facilities or storage locations identified that could have a significant impact on Units 6 & 7. The evaluation for those facilities located greater than 5 miles from Units 6 & 7 was based on identifying whether any of these facilities contained highly toxic, highly volatile chemicals not bounded by the onsite storage of these chemicals with risk management program calculated endpoint distances of at least 25 miles (References 224, 225, and 226). Therefore, further analysis beyond these two facilities and the onsite chemical storage facilities associated with Units 6 & 7 is not required.

2.2.2.2.1 Turkey Point Plant

Units 1 through 5 are located on the approximate 11,000-acre Turkey Point plant property. Units 1 and 2 are gas/oil-fired steam electric generating units; Units 3 and 4 are nuclear powered steam electric generating units; and Unit 5 is a natural gas combined cycle plant. The two 400 MW (nominal) gas/oil-fired steam electric generation units have been in service since 1967 (Unit 1) and 1968 (Unit 2). These units currently burn residual fuel oil and/or natural gas with a maximum equivalent sulfur content of 1 percent. The two 700 MW (nominal) nuclear units are pressurized water reactor units that have been in service since 1972 (Unit 3) and 1973 (Unit 4). Unit 5 is a nominal 1150 MW combined-cycle unit that began operation in 2007 (Reference 244).

Units 6 & 7 are located southwest of Units 1 through 5 as delineated on the site area maps (Figures 2.1-203 and 2.1-205). The center point of the Unit 6 reactor building is approximately 215 feet west and 3625 feet south of the center point of the Unit 4 containment. The chemicals identified for possible analysis and their location associated with Units 1 through 5 and the onsite chemical storage facilities associated with Units 6 & 7 are presented in Table 2.2-202. The disposition of hazards associated with these chemicals is summarized in Tables 2.2-207 and 2.2-208 and the subsequent analysis of these chemicals is addressed in Subsection 2.2.3.

2.2.2.2.2 Homestead Air Reserve Base

The Homestead Air Reserve Base is located approximately 4.76 miles north-northwest of Units 6 & 7 (Figure 2.2-201). Construction of a fully operating

military base (Homestead Army Air Field) began at the current Homestead Air Reserve Base site in September of 1942 to serve as a maintenance and fueling stopover for aircraft headed overseas during World War II.

Today, the 482nd Fighter Wing, the host unit of Homestead Air Reserve Base, continues to support contingency and training operations of U.S. Southern Command and a number of tenant units including Headquarters Special Operations Command South, U.S. Coast Guard Maritime Safety and Security Team, and an air and maritime unit of U.S. Customs and Border Protection. The Homestead Air Reserve Base is a fully combat-ready unit capable of providing F-16C multipurpose fighter aircraft, along with mission ready pilots and support personnel, for short-notice worldwide deployment. In addition, the Homestead Air Reserve Base is home to the most active North American Aerospace Defense Command alert site in the continental United States, operated by a detachment of F-15 fighter interceptors from the 125th Fighter Wing Florida Air National Guard.

The Homestead Air Reserve Base has 2365 total personnel including 267 active-duty personnel, 1245 Air Force Reserve Command and National Guard personnel, 779 civilians, and 74 civilian contractors (References 202 and 203). The chemicals stored at the Homestead Air Reserve Base identified for possible analysis are presented in Table 2.2-203. The disposition of hazards associated with these chemicals is summarized in Table 2.2-209 and the subsequent analysis of these chemicals is addressed in Section 2.2.3.

2.2.2.3 Description of Pipelines

There are two natural gas transmission pipelines operated by Florida Gas Transmission Company within 5 miles of the plant as depicted in Figure 2.2-201. The Florida Gas Transmission Company owns and operates a high-pressure natural gas pipeline system that serves FPL and other customers in south Florida. Two of the pipelines, the Turkey Point Lateral and the Homestead Lateral, are located within 5 miles of Units 6 & 7. A more detailed description of the pipelines are presented in the following subsection, including the pipe size, age, operating pressure, depth of burial, location and type of isolation valves, and type of gas or liquid presently carried. Information pertaining to the various pipelines is also presented in Table 2.2-204.

2.2.2.3.1 Florida Gas Transmission Company/Turkey Point Lateral Pipeline

The Florida Gas Transmission Company Turkey Point Lateral is a 24-inch diameter pipeline that was installed in 1968. The pipeline operates at a maximum

pressure of 722 pound-force per square inch gauge (psig) and provides gas service to Turkey Point's gas-fired power plants. The pipeline is buried to an approximate depth of 42 inches below grade. The nearest isolation valve is located approximately 11.8 miles from the south end of the 24-inch Turkey Point Lateral. The isolation valve is manually operated. At the closest approach to Units 6 & 7, the Turkey Point Lateral pipeline, depicted on Figure 2.2-201, passes within approximately 4535 feet of the Unit 6 auxiliary building. The Turkey Point Lateral transports natural gas and there are not any future plans to transport any other products (Reference 204).

2.2.2.3.2 Florida Gas Transmission Company/Homestead Lateral Pipeline

The Florida Gas Transmission Company Homestead Lateral is a 6.625-inch diameter pipeline that tees off of the 24-inch Turkey Point Lateral approximately 3 miles north of the Turkey Point site and extends in a westward direction to provide gas service to the City of Homestead. The Homestead Lateral was installed in 1985, and also operates at a maximum pressure of 722 psig. This pipeline is buried to an approximate depth of 42 inches below grade. There is a manually operated isolation valve located just downstream of the 24 inch by 6 inch tee at the take-off of the Homestead Lateral. The Homestead Lateral transports natural gas and there are not any future plans to transport any other products (Reference 204). Because of the proximity and diameter of the Turkey Point Lateral pipeline in comparison to the Homestead lateral pipeline, the Turkey Point Lateral pipeline presents a greater hazard, and as such, the Turkey Point Lateral pipeline analysis is bounding and no further analysis of the Homestead Lateral pipeline is warranted.

2.2.2.4 Description of Waterways

Units 6 & 7 are located on the western shore of south Biscayne Bay. Biscayne Bay is a shallow coastal lagoon located on the lower southeast coast of Florida (Reference 258). The bay is approximately 38 miles long, approximately 11 miles wide on average, and has an area of approximately 428 square miles (References 259 and 260). On the southern portion of the Biscayne Bay where Units 6 & 7 are located, the bay is approximately 8 miles wide and 9 miles long and extensive sandbars exist. South Biscayne Bay is separated from Card Sound to the south by a sandbar area encompassing the Arsenicker Keys and Cutter Bank. The nearshore shallow areas of the western side of south Biscayne Bay are generally less than 5 feet deep (Reference 205).

The Biscayne Bay contains the Miami to Key West, Florida Intracoastal Waterway. The only commodity transported on the Miami to Key West, Florida Intracoastal Waterway is residual fuel oil. In 2005, there were 611,000 short tons of residual fuel oil transported, and the entirety of this commodity was delivered to the Turkey Point plant (Table 2.2-205, Reference 206).

The Turkey Point turning basin is approximately 300 feet wide, 1200 feet long and approximately 20 feet deep (Reference 205). The Turkey Point fuel unloading dock is located on the north side of the turning basin. The concrete constructed fuel oil dock at the Turkey Point plant can handle one barge at a time. Residual fuel oil is delivered exclusively by barges that typically are approximately 228 feet long, 54 feet wide, and have a draft of 6.5 feet when loaded. This size barge will transport approximately 18,000 barrels of oil. Residual fuel oil is unloaded from the barges to the two fuel oil storage tanks located north of the unloading dock. In a typical week, five to seven deliveries of oil may be made and each delivery requires about 5 hours to unload. Because the storage of residual fuel oil at the Turkey Point site, two 268,000 barrel tanks, exceeds the quantity transported by a barge, the storage tanks present a greater hazard, and as such, the analysis of residual fuel oil located in the storage tanks is bounding and no further analysis of the residual fuel oil transported by the barge is warranted.

2.2.2.5 Description of Highways

Miami-Dade County is traversed by several highways. Interstate 95, U.S. Highway 1 and the Florida Turnpike (State Road 821) are the major transportation routes for north-south traffic flow in the county. The major route for east-west movement is U.S. Route 41 which crosses the middle of the county (Reference 207). Main access to the Turkey Point site is Palm Drive (SW 344th Street), which runs in an east-west direction along the northern boundary of the Turkey Point site. Palm Drive provides a connection with U.S. Highway 1 and the Florida Turnpike. There are no major highways within 5 miles of Units 6 & 7 (Figure 2.2-201, References 201 and 207).

To ascertain which hazardous materials may be transported on the roadways within 5 miles of Units 6 & 7, the industries that may store hazardous materials—and, hence, have either the materials transported to the site or transported from the site—were identified through SARA Title III, Tier II reports as described in Subsection 2.2.2.2. The only identified chemicals whose transportation route may approach closer than 5 miles to Units 6 & 7 are those chemicals transported onto the Turkey Point plant property. Of these chemicals, gasoline was the only identified roadway transportation event that is not bounded

by an event involving the onsite storage vessel for each identified chemical. Each of the identified onsite chemicals that had the potential to explode, or form a flammable or toxic vapor cloud, is analyzed to determine safe distances.

2.2.2.6 Description of Railroads

There are no railroads in the vicinity (5 miles) of Units 6 & 7 (Figure 2.2-201, Reference 207).

2.2.2.7 Description of Airports

In accordance with RG 1.206 and RG 1.70, Homestead Air Reserve Base is the only identified airport located within the vicinity (5 miles) of Units 6 & 7 other than the Turkey Point Heliport located onsite. Further, RG 4.7 recommends that major airports within 10 miles be identified. The Ocean Reef Club Airport is a small private airport located approximately 7.4 miles from Units 6 & 7 (Figure 2.2-202, References 223 and 240).

A more detailed description of each of these airports is presented in the subsequent sections, including distance and direction from the site, number and type of aircraft based at the airport, largest type of aircraft likely to land at the airport facility, runway orientation and length, runway composition, hours attended, and yearly operations where available. Information pertaining to airports located within 10 miles of the site is presented in tabular form in Table 2.2-206. A screening evaluation of the closest major airport in the region, Miami International Airport, is also included in this table to ascertain whether this airport is or may be of significance in the future.

2.2.2.7.1 Airports

2.2.2.7.1.1 Turkey Point Heliport

The Turkey Point site operates its own corporate heliport. The Turkey Point heliport is located in the southeast corner of the Units 3 & 4 parking lot approximately 3100 feet north of Units 6 & 7. The heliport is an approximate 22-foot by 22-foot concrete pad. The maximum gross weight of the helicopter operated at the site, an Agusta A109E Power Helicopter, is 6600 pounds. There were approximately 79 takeoffs and landing operations in 2007. As described in Subsection 2.2.2.7.2, it is not expected that an aircraft of this weight and size would have an impact on safety-related structures (References 227 and 228). Further, the number of operations at the heliport, especially in comparison with

other aviation facilities is infrequent. Due to the weight of the aircraft (thus low penetration hazard) using the heliport and infrequent operations, no further analysis of the heliport is warranted.

2.2.2.7.1.2 Homestead Air Reserve Base

Homestead Air Reserve Base is located approximately 4.76 miles north-northwest from the proposed Units 6 & 7. The U.S. Air Force owns the airport, and the airport is for private use, with permission required before landing. The airport has a concrete/grooved runway, Runway 05/23, which is 11,200 feet long and 300 feet wide. The runway headings are 50 degrees (Runway 05) and 230 degrees (Runway 23). The traffic pattern for Runway 05 is right and the traffic pattern for Runway 23 is left (Reference 209).

The Homestead Air Reserve Base has approximately 36,429 annual operations and this projection is not expected to change over the period of the license duration (Reference 208). Consistent with RG 1.206, the Homestead Air Reserve Base located approximately 4.76 miles from the site, was considered because the plant-to-airport distance is less than 5 miles.

Homestead Air Reserve Base indicated that the military aircraft onsite consisted of F-16Cs with a wingspan of 32 feet 10 inches and F-15As with a wingspan of 42 feet 9 inches. The reported number of military operations was 24,902 per year. The Homestead Air Reserve Base also indicated that there were 7430 operations per year from U.S. Customs Border Patrol aircraft along with 4097 transient aircraft operations per year (Reference 208).

2.2.2.7.1.3 Ocean Reef Club Airport

Ocean Reef Club Airport is a privately owned airport located 7.41 miles south southeast from Units 6 & 7. The airport is an amenity associated with the Ocean Reef Club. All aircraft must be registered and permission is required before landing. There is no scheduled airline service associated with the airport and the airport is unattended (Reference 242).

The airport has an asphalt runway that is 4500 feet long and 70 feet wide. The runway headings are 40 degrees (Runway 04) and 220 degrees (Runway 22). The landing pattern is to the left. There are approximately 25 aircraft based on the site, 15 single-engine planes and 10 multi-engine planes. The plant-to-airport distance criteria in accordance with NUREG-0800 is $500D^2$, where D is the distance in statute miles from the site, for airports located within 5 to 10 statute miles from the site, giving the airport a significance factor of 27,454 operations per

year. The airport is an unattended private facility with just 25 aircraft based on the field with no control tower (References 209 and 210). To reach a significance factor of 27,454 operations, each aircraft would need to average approximately 1,098 operations per year. Therefore, it is reasonably assumed that the airport operations at this facility meet the plant-to-airport distance/annual operations criteria and no further evaluation is warranted.

2.2.2.7.2 Aircraft and Airway Hazards

There is one airport, Homestead Air Reserve Base, located approximately 4.76 miles from Units 6 & 7. The Homestead Air Reserve Base has approximately 36,429 annual operations and this projection is not expected to change over the period of the license duration (Reference 208). As required by RG 1.206, an aircraft hazard analysis should be provided for all airports with a plant-to-airport distance less than 5 statute miles from the site.

The Units 6 & 7 site meets acceptance criteria 1.B. of Section 3.5.1.6 of NUREG-0800—there are no military training routes or military operations areas within 5 miles of the site. The centerline of the closest military training route, IR-53, is approximately 11.5 nautical miles, 13.2 statute miles, from Units 6 & 7, while the closest military operations area, Lake Placid military operations area, is approximately 115 nautical miles or 132.3 statute miles from Units 6 & 7 (Reference 223).

The Units 6 & 7 site is located closer than 2 statute miles to the nearest edge of a federal airway. The site is approximately 5.98 statute miles from the centerline of airway V3/G439 as depicted in Figure 2.2-202. The width of a federal airway is typically 8 nautical miles, 4 nautical miles (4.6 statute miles) on each side of the centerline, placing the airway approximately 1.4 statute miles to the nearest edge (Reference 211). The edge of the closest high altitude airway is located further than 2 statute miles from Units 6 & 7 (Reference 240). Because of the proximity of airway V3/G439 to Units 6 & 7, criteria 1.C. set in Section 3.5.1.6 of NUREG-0800 that the plant is at least 2 statute miles beyond the nearest edge of a federal airway is not met.

Therefore, a calculation to determine the probability of an aircraft accident that could possibly result in radiological consequences to the site was performed following NUREG-0800 and DOE-STD-3014-96 to determine whether the accident probability rate is less than an order of magnitude of 1E–07. The probability of an aircraft crashing into the plant and its impact frequency evaluation are estimated using a four-factor formula that considers: (1) the number of

operations; (2) the probability that an aircraft will crash; (3) given a crash, the probability that the aircraft crashes into a 1-square-mile area where the facility is located; and (4) the size of the facility. In order to estimate aircraft crash frequencies, this method applies the four-factor formula to two different flight phases, near-airport activities or airport operations that considers takeoffs and landings, and non-airport activities or in-flight phase operations (Reference 212). This assessment of impact frequency assumes that all impacts will lead to facility damage and a possible release of radioactive material.

Mathematically, the four-factor formula is:

$$F = \Sigma N_{ijk} * P_{ijk} * f_{ijk}(x,y) * A_{ij} \qquad \text{(Equation 1)}$$

Where,

F	=	estimated annual aircraft crash impact frequency for the facility of interest (no./year)
N_{ijk}	=	estimated annual number of site-specific aircraft operations for each applicable summation parameter (no./year)
P_{ijk}	=	aircraft crash rate (per takeoff or landing for near-airport phases and per flight for the in-flight (non-airport) phase of operation for each applicable summation parameter)
$f_{ijk}(x,y)$	=	aircraft crash location conditional probability (per square mile) given a crash evaluated at the facility location for each applicable summation parameter
A_{ij}	=	the site-specific effective area for the facility of interest that includes skid and fly-in effective areas (square miles) for each applicable summation parameter, aircraft category or subcategory, and flight phase for military aviation
i	=	(index for flight phases): i=1, 2, and 3 (takeoff, in-flight, and landing)
j	=	(index for aircraft category or subcategory): j=1, 2, …, 11
k	=	(index for flight source): k=1, 2, …, k
Σ	=	$\Sigma k\ \Sigma j\ \Sigma i$
ijk	=	site-specific summation over flight phase, i; aircraft category or subcategory, j; and flight source, k

Effective Area

The effective area was calculated using the method provided in the DOE Standard, DOE–STD-3014-96 (Reference 212). For the AP1000 design, the

safety-related structures are contained on the nuclear island which consists of the containment or shield building and the auxiliary building. To calculate a conservative estimate of the effective target area, a bounding building was used in accordance with the DOE standard with the following assumptions:

- The total footprint area of the safety-related structures was obtained to estimate the equivalent width/length (W, L) of a bounding building, and thus the building diagonal length, R.
- For the AP1000 design, when determining the length, L of the bounding building, the actual length of the auxiliary building, 254 feet, was used.
- The total volume of the bounding building is obtained in order to estimate the equivalent height of the rectangular bounding building.
- In this calculation, the 78-foot wingspan was conservatively chosen to represent military aircraft wingspan. Homestead Air Reserve Base indicated that the military aircraft on site consisted of F-16Cs with a wingspan of 32 feet 10 inches and F-15As with a wingspan of 42 feet 9 inches (Reference 208).

Based on those assumptions, the effective areas for general aviation, air carrier, air taxi and commuter, large military (takeoff), large military (landing), small military (takeoff), and small military (landing) type of aircraft are 0.01730, 0.04309, 0.03859, 0.03775, 0.03660, 0.02166, and 0.02824 square miles, respectively.

Airport Operations Impact Frequency

Using the four-factor formula, the total impact frequency from airport operations, which includes near airport activities and considers takeoffs and landings, into the plant was determined to be 2.56E-07 per year. Even though most of the airport operations are attributed to small military aircraft operations, the calculated impact frequency was dominated by general aviation operations. The lower impact frequency attributed to Homestead Air Reserve Base is largely due to the orientation of the runway at Homestead Air Reserve Base. Crash location probability values are primarily distributed about the x-axis, the extended runway centerline—for military aircraft, this distribution is also dependent on the pattern side of the runway. When the x-axis is placed along the center of the runway, the Units 6 & 7 site lies nearly on the y-axis, accounting for the low crash location probabilities for airport operations. In determining the airport operation frequency, the following assumptions were formulated:

- Based on data received from Homestead Air Reserve Base, it was assumed that for each aircraft category, 75 percent of the operations occurred on Runway 05 and 25 percent of the operations occurred on Runway 23, resulting in:
  - 18,678 small military operations for Runway 05
  - 6,226 small military operations for Runway 23
  - 5,574 large military operations for Runway 05
  - 1,858 large military operations for Runway 23
  - 3,074 general aviation operations for Runway 05
  - 1,026 general aviation operations for Runway 23

Non-Airport Operations Impact Frequency

For non-airport operations, or the in-flight phase, methods provided in DOE Standard DOE-STD-3014-96 were used and the total impact frequency from non-airport operations into the plant was determined to be 3.61E-06 per year (Reference 212).

The determined impact frequency using this methodology is heavily weighted towards general aviation aircraft due to the large probability, N * P * f(x,y), of general aviation crashes throughout the continental United States. The analysis of non-airport operations impact frequency was based on the four-factor formula, as used for airport operations for the class of aircraft *j*:

$$F_j = N_j * P_j * f_j (x,y) * A_j$$

Where, the product NP represents the expected number of in-flight crashes per year; f(x,y) is the probability, given a crash, that the crash occurs in a 1-square-mile area surrounding the facility of interest, and A is the effective area of the facility (Reference 212). For this calculation, the values of N * P * f(x,y) selected are the continental U.S. averages.

Total Impact Frequency

This assessment led to a total impact frequency of 3.86E-06 per year when considering both the airport and non-airport operations, which is greater than an order of magnitude of 1E-07 per year. Therefore, consideration of whether the

damage from the aircraft crash may result in radiological releases in excess of the exposure guidelines in 10 CFR Part 100 was considered for general aviation and commercial aircraft categories. The General Aviation category dominates the impact frequency results. Studies of General Aviation and Commercial Aircraft categories conclude that impacts from these categories are not likely to result in core damage. In these instances (General Aviation and Commercial Aircraft categories), crash probabilities are multiplied by appropriate conditional probabilities of a radioactive material release exceeding 10 CFR Part 100 guidelines to obtain the consequence probabilities of such a release. The impact of aircraft and aircraft missiles on substantial concrete structures has been extensively studied and a core damage probability can reasonably be applied to the calculated total impact frequency for the General Aviation and Commercial Aircraft categories (References 227 and 228). NUREG/CR-4839 cites a conditional core damage probability of 0.1 as a conservative estimate. Therefore, for this calculation, a conditional core damage probability of 0.1 was conservatively applied to the General Aviation and Commercial Aircraft categories. Conservatively, a conditional core damage probability of 1.0 was applied to the small and large military aviation categories.

Taking into account the conditional core damage probability, the rate of aircraft accidents that could lead to radiological consequences in excess of the exposure guidelines of 10 CFR 50.34(a)(1) is 4.86E-07 crashes per year. This includes the following inherent conservatisms:

- Shielding by adjacent structures, topographical features, and barriers was not credited. The skid distance would virtually be eliminated, reducing the effective area, if this were credited, because the nuclear island is shielded on three sides and partially on the fourth side by other structures.

- A conservative value of the conditional core damage probability was used. General Aviation aircraft was not screened out, that is, a core damage probability of zero was not applied to the general aviation class, even though studies have shown they are not considered a significant hazard to nuclear power stations because of their low weight and low penetration hazard.

- DOE methodology has conservatisms built in. One example is in determining the effective area of the bounding building where the heading of the crashing aircraft with respect to the facility is assumed to be the worst case which is perpendicular to the diagonal of the bounding rectangle regardless of direction of actual flights.

Therefore, a value of 4.86E-07 aircraft crashes per year that may lead to radiological consequences meets the guidance in NUREG-0800, Section 3.5.1.6 which states that 10 CFR 100.1, 10 CFR 100.20, 10 CFR 100.21, 10 CFR 52.17, and 10 CFR 52.79 requirements are met if the probability of aircraft accidents resulting in radiological consequences greater than the 10 CFR Part 100 exposure guidelines is less than an order of magnitude of 1E-07 per year. The value of 4.86E-07 aircraft crashes per year that may lead to radiological consequences also meets RG 1.206 guidance, which states that plant design should consider aircraft accidents that could lead to radiological consequences in excess of the exposure guidelines of 10 CFR 50.34(a)(1) and 10 CFR 52.79 with a probability of occurrence greater than an order of magnitude of 1E–07 per year.

2.2.2.8 Projections of Industrial Growth

The Units 6 & 7 site is located in unincorporated Miami-Dade County, Florida. Miami-Dade County has adopted a Comprehensive Development Master Plan to meet the requirements of the Local Government Comprehensive Planning and Land Development Regulation Act, Chapter 163, Part II, Florida Statutes, and Chapter 9J-5, Florida Administrative Code. The Comprehensive Development Master Plan was last revised in October 2006.

The Comprehensive Development Master Plan Map illustrates the locations of major institutional uses, communication facilities, and utilities of metropolitan significance. The 2025 expansion area boundary delineated on the Land Use Plan Map does not depict any future industrial area expansion within 5 miles of Units 6 & 7 (Reference 213).

Thus, a review of Miami-Dade County's Comprehensive Development Master Plan does not indicate any future projections of new major industrial, military, or transportation facilities located within the vicinity of the Units 6 & 7 site (Reference 213).

2.2.3 EVALUATION OF POTENTIAL ACCIDENTS

An evaluation of the information provided in Subsections 2.2.1 and 2.2.2, for potential accidents that should be considered as design basis events, and the potential effects of those identified 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,

52.79, 50.34, 100.20, and 100.21, using the guidance contained in RG 1.78, 1.91, 4.7, and 1.206.

2.2.3.1 Determination of Design-Basis Events

RG 1.206 states that design basis events, internal and external to the nuclear plant, are defined as those accidents that have a probability of occurrence on the order of magnitude of 1E-07 per year or greater with potential consequences serious enough to exceed the guidelines in 10 CFR Part 100 affecting the safety of the plant. The following accident categories are considered in selecting design basis events: explosions, flammable vapor clouds (delayed ignition), toxic chemicals, fires, collisions with the intake structure, and liquid spills. On the basis of the identification of industrial, transportation, and military facilities presented in Subsections 2.2.1 and 2.2.2, the postulated accidents within these categories are analyzed at the following locations:

- Onsite chemical storage (Units 1 through 5)
- Onsite chemical storage (Units 6 & 7)
- Nearby chemical and fuel storage facilities (Homestead Air Reserve Base)
- Nearby transportation routes (Florida Gas Transmission Company (Turkey Point Lateral-natural gas transmission pipeline), and an onsite transportation route)

2.2.3.1.1 Explosions

Accidents involving detonations of explosives, munitions, chemicals, liquid fuels, and gaseous fuels are considered for facilities and activities either onsite or within the vicinity of the plant, where such materials are processed, stored, used, or transported in quantity. NUREG-1805 defines explosion as a sudden and violent release of high-pressure gases into the environment. 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 214).

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 are evaluated to determine if the explosion would have an adverse effect on plant operation or would prevent safe shutdown of the plant.

2.2.3.1.1.1 Explosions /Trinitrotoluene Mass Equivalency

The onsite chemicals (Units 1 through 5 [Table 2.2-207] and Units 6 & 7 [Table 2.2-208]), offsite chemical storage (Homestead Air Reserve Base [Table 2.2-209]), hazardous materials transported in pipelines (Turkey Point Lateral [Table 2.2-210]), and hazardous materials potentially transported on roadways (Table 2.2-210) were evaluated to ascertain which hazardous materials had a defined flammability range, upper (UFLs) and lower (LFLs) flammability limits, with a potential to explode upon detonation. 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. 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. The concentrations of formed vapors or gases have an upper and lower bound known as the UFL and the 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 215).

The postulated accidents, involving those hazardous materials determined to have the potential to explode, involve 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 (e.g., flammable liquids are present in the gas/vapor phase between the UFL and LFL). The trinitrotoluene (TNT) mass equivalency methodology employed for determining the safe distances, the minimum separation distance required for an explosive force to not exceed 1 psi peak incident pressure, involve a compilation of principles and criterion from RG 1.91, NUREG-1805, National Fire Protection Association (NFPA) Code, and pertinent research papers.

The allowable and actual safe distances for hazardous materials transported or stored were determined in accordance with RG 1.91, Revision 1. RG 1.91 cites 1 psi (6.9 kilopascal) as a conservative value of positive incident over pressure below which no significant damage would be expected. RG 1.91 defines this safe distance by the Hopkinson Scaling Law Relationship:

$$R \geq kW^{1/3} \qquad \text{(Equation 2)}$$

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 ft/lb$^{1/3}$).

The methodology for calculating, W, and hence the safe distance, R, is dependent on the phase—solid, atmospheric liquid, or pressurized or liquefied gas—of the chemical during storage and/or transportation.

Solids

For a solid substance not intended for use as an explosive but subject to accidental detonation, RG 1.91 states that it is conservative to use a TNT mass equivalent (W) in Equation 2 equal to the cargo mass.

Atmospheric Liquids

RG 1.91 states that it is *limited to solid explosives and hydrocarbons liquefied under pressure,* and the guidance provided in determining W, the mass of the substance that will produce the same blast effect as a unit mass of TNT, is specific to solids. Therefore, the guidance for determining the TNT mass equivalent, W, in RG 1.91, where the entire mass of the solid substance is potentially immediately available for detonation, is not applicable to atmospheric liquids, where only that portion in the vapor phase between the UFL and LFL is available to sustain an explosion.

The methodology employed conservatively considers the maximum gas or vapor volume within the storage vessel 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 in accordance with NUREG-1805. Therefore, for atmospheric liquids, the TNT mass equivalent, W, was determined following guidance in NUREG-1805, where

$$W = (M_{vapor} * \Delta H_c * Y_f) / 2000 \qquad \text{(Equation 3)}$$

Where M_{vapor} is the flammable vapor mass (lbs), ΔH_c is the heat of combustion of the substance (Btu/lb), 2000 is the heat of combustion of TNT (Btu/lb), and Y_f is the explosion yield factor. The yield factor is an estimation of the explosion efficiency, or a measure of the portion of the flammable material participating in the explosion. Conservatively, an explosion yield factor of 100 percent was applied to account for a confined

explosion (NUREG-1805). In reality, only a small portion of the vapor within the flammability limits would be available for combustion and potential explosion, and a 100 percent yield factor is not achievable (Reference 216).

Pressurized or Liquefied Gases

For liquefied and pressurized gases, the entire mass is conservatively considered as a flammable gas/vapor because a sudden tank rupture could entail the rapid release and mixing of a majority of the contents and a confined explosion could possibly ensue. For example, in the case of liquefied gases, the liquefied gas would violently expand and mix with air while changing states from the liquid phase to a vapor/aerosol phase. Therefore, in the case of pressurized or liquefied gases, the entire mass is conservatively considered as available for detonation, and the equivalent mass of TNT, W, is calculated in accordance with NUREG-1805 (Equation 3) where the M_{vapor} is the flammable mass (pounds) and the entire mass of the pressurized or liquefied gas is considered flammable. Again, an explosion yield factor of 100 percent was conservatively assumed to account for a confined explosion (NUREG-1805).

2.2.3.1.1.2 Boiling Liquid Expanding Vapor Explosions

A boiling liquid expanding vapor explosion (BLEVE) is an additional concern with closed storage tanks that contain substances that are gases at ambient conditions but are stored in a vessel under pressure in its saturated liquid/vapor form. The NFPA defines a BLEVE as the failure of a major container into two or more pieces, occurring at a moment when the contained liquid is at a temperature above its boiling point at normal atmospheric pressure. If the chemical is above its boiling point when the container fails, some or all of the liquid will flash-boil, that is, instantaneously become a gas. This phase change forms blast waves with energy equivalent to the change in internal energy of the liquid/vapor. This phenomenon is called a BLEVE. If the chemical is flammable, a burning gas cloud called a fireball may occur if a significant amount of the chemical flash-boils. Because thermal radiation impacts a greater area than the overpressure, it is the more significant threat, and therefore, thermal heat flux values are presented for substances capable of producing a BLEVE (NUREG-1805).

The onsite chemicals (Units 1 through 5 [Table 2.2-207] and Units 6 & 7 [Table 2.2-208]), offsite chemical storage (Homestead Air Reserve Base, [Table 2.2-209]), hazardous materials transported in pipelines (Turkey Point Lateral [Table 2.2-210]), and hazardous materials potentially transported on

roadways (Table 2.2-210) were evaluated to ascertain which hazardous materials had a defined flammability range, upper and lower flammability limits, with a potential to produce a BLEVE. That is, those chemicals stored in their saturated liquid form but are gases at ambient conditions. The Areal Locations of Hazardous Atmospheres (ALOHA) model was used to model the worst-case accidental BLEVE for each chemical identified as capable of producing a BLEVE, calculated as the thermal heat flux at the nearest safety-related structure. To model the worst-case BLEVE in ALOHA, the meteorological conditions presented in Table 2.2-212 were used as inputs and the determined worst-case meteorological case for each substance was used as site atmospheric input for the BLEVE analysis.

Other inputs/assumptions for the BLEVE analysis using the ALOHA model include:

- "Open Country" was selected for the ground roughness. The degree of atmospheric turbulence influences how quickly a pollutant cloud moving downwind will mix with the air around it and be diluted. In the case of a BLEVE, the movement of a vapor cloud is not a consideration.

- The "Threat at Point" function was selected with no crosswind in the ALOHA modeling runs. This effectively models the chemical release as a direct-line source from the spill site to the point of concern, the nearest safety-related structure for Units 6 & 7.

- The "Level of Concern" selected was 5.0 kilowatts per square meter (kW/m^2). At 5.0 kW/m^2, second-degree burns are expected to occur within 60 seconds (Reference 217). Further, the EPA has selected 5.0 kW/m^2 for 40 seconds as its level of concern for heat from fires in EPA's Risk Management Program Guidance for Offsite Consequence Analysis (Reference 220). Regarding damage to structures, as a point of reference, the ignition threshold for wood is 40 kW/m^2 (NUREG-1805).

In each of the explosion scenario analyses in the subsequent subsections, the described TNT mass equivalency methodology or BLEVE methodology was employed to determine the safe distances. The effects of these explosion events from both internal and external sources are summarized in Table 2.2-213, and are described in the following subsections relative to the release source.

2.2.3.1.1.3 Onsite Chemical Storage/Units 1 through 5

Units 6 & 7 are located close to the existing Units 1 through 5 chemical storage locations. The hazardous materials stored on site that were identified for further analysis with regard to explosion potential were acetylene, ammonium hydroxide, hydrazine, hydrogen, and propane. A conservative analysis using the TNT equivalency methods described in Subsection 2.2.3.1.1.1 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 Unit 6 auxiliary building, to each storage location. The safe distance for acetylene is 1416 feet; for ammonium hydroxide, 296 feet; for hydrazine, 170 feet; for hydrogen, 1098 feet; and for propane, 1299 feet (Table 2.2-213). Acetylene is stored approximately 4300 feet; ammonium hydroxide approximately 5079 feet; hydrazine approximately 2727 feet; hydrogen approximately 3966 feet; and propane 4168 feet; from the nearest safety-related structure for Units 6 & 7—the Unit 6 auxiliary building. Therefore, an explosion from any of the onsite hazardous materials evaluated will not adversely affect the safe operation or shutdown of Units 6 & 7.

Additionally, propane was identified for further analysis with regard to its potential for forming a BLEVE. The propane tank located at Turkey Point site is determined to bound propane storage at the Homestead Air Reserve Base due to the large distance separating propane storage at the Homestead Air Reserve Base and Units 6 & 7. A conservative analysis using the ALOHA model described in Subsection 2.2.3.1.1.2 is used to determine the safe distance—the distance to the thermal heat flux of 5 kW/m^2 from the formation of a fireball. Inputs to the ALOHA model also included the dimensions of the propane tank with a diameter of 3.08 feet and a length of 9.92 feet. The safe distance for propane is 603 feet. Propane is stored 4168 feet from the nearest safety-related structure for Units 6 & 7—the Unit 6 auxiliary building. The thermal radiation heat flux at the nearest safety-related structure is 0.0878 kW/m^2 and the calculated burn duration is 5 seconds. Therefore, the thermal radiation heat flux resulting from a BLEVE from the storage of propane will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.1.4 Onsite Chemical Storage/Units 6 & 7

The chemicals associated with Units 6 & 7 that were identified for further analysis with regard to explosion potential were methanol, hydrazine, morpholine, and the hydrogen storage banks. A conservative analysis using the TNT equivalency methods described in Subsection 2.2.3.1.1.1 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 Unit 6 or Unit 7 auxiliary building—to each storage location. The safe distance for methanol is 344 feet; for hydrazine, 153 feet; for morpholine 136 feet; and for hydrogen, 544 feet (Table 2.2-213). Methanol is stored at the FPL reclaimed water treatment facility approximately 5581 feet from the nearest safety-related structure for Units 6 & 7—the Unit 7 auxiliary building. Hydrazine and morpholine are stored approximately 218 feet; and hydrogen approximately 560 feet from the nearest safety-related structure for Turkey Point Units 6 & 7—the Unit 6 or Unit 7 auxiliary building. Therefore, an explosion from any of the onsite hazardous materials evaluated will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.1.5 Nearby Facilities/Homestead Air Reserve Base

The Homestead Air Reserve Base, located approximately 4.76 miles (25,133 feet) from the nearest safety-related structure for Units 6 & 7, the Unit 6 auxiliary building, is the identified facility of concern within the vicinity of the Turkey Point site as determined in Subsection 2.2.2.2.2. The hazardous materials stored at the Homestead Air Reserve Base identified for further analysis were: gasoline, hydrazine, jet fuel, and propane. A conservative analysis using the TNT equivalency methods described in Subsection 2.2.3.1.1.1 is used to determine safe distances for the identified hazardous materials. The results indicate that the safe distances are less than the minimum separation distances from the Unit 6 auxiliary building to the storage locations for any of the identified chemicals (Table 2.2-213). Propane resulted in the largest safe distance, 5,513 feet, which is less than the distance of 4.76 miles (25,133 feet) to the nearest safety-related structure for Units 6 & 7. Therefore, damaging overpressures from an explosion resulting from a complete failure of the total stored quantity for each chemical evaluated at Homestead Air Reserve Base would not adversely affect the operation or shutdown of Units 6 & 7.

2.2.3.1.1.6 Transportation Routes/Roadways

The safety-related structure located closest to identified transportation routes/roadways, the Unit 6 auxiliary building, is located approximately 2054 feet (at its closest point of approach) from the onsite transportation delivery route for gasoline. As detailed in Subsections 2.2.3.1.1.4 and 2.2.3.1.1.5, deliveries of chemicals to the site were screened and determined to be bounded by the evaluation performed for the onsite storage quantities. The maximum quantity of gasoline assumed to be transported is 50,000 pounds (9,000 gallons) in

accordance with RG 1.91. An evaluation was conducted using the TNT equivalency methodologies described in Subsection 2.2.3.1.1.1 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 Unit 6 auxiliary building identified above and in Table 2.2-213. Therefore, an explosion from potentially transported hazardous materials on site will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.1.7 Transportation Routes/Pipelines

As described in Subsection 2.2.2.3, the Florida Gas Transmission Company owns and operates a high-pressure natural gas transmission pipeline system that serves FPL and other customers in south Florida. Two of the pipelines in this system are located within 5 miles of Units 6 & 7. The closest pipeline, the Turkey Point Lateral, represents the bounding condition. The nearest safety-related structure, the Unit 6 auxiliary building, is 4535 feet away from the analyzed release point, the closest approach of the nearest natural gas transmission pipeline.

Experiments conducted in Germany (Reference 218) and by the Institution of Gas Engineers (Reference 219) have indicated that detonations of mixtures of methane (greater than 85 percent) with air do not present a credible outdoor explosion event (Reference 216). Further, there have been no reported vapor cloud explosions involving natural gas with high methane content—there have been numerous reports of vapor clouds igniting resulting in flash fires without overpressures (Reference 216). In evaluating similar research, Y. -D. Jo and Ahn report that when leaked natural gas is not trapped and immediate ignition occurs, only a jet fire will develop. Thus, the dominant hazards from natural gas pipelines are from the heat effect of thermal radiation from a sustained jet fire and from explosions where the natural gas vapor cloud becomes confined either outside or by migration inside a building (Reference 245). Even though the immediate ignition of natural gas resulting in overpressure events resulting from a ruptured gas pipeline is considered an unlikely event, an evaluation was conservatively conducted to evaluate a potential explosion from the natural gas transmission pipeline.

The worst case scenario considered the immediate deflagration/detonation of the released natural gas. That is, upon immediate release, the contents of the pipeline are assumed to be capable of supporting an explosion upon detonation (i.e., the gas is present in concentrations between the UFL and LFL). 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. The safe distance to 1 psi overpressure is calculated by determining the mass of natural gas released, whereby the TNT mass equivalency methodology can then be employed as described in Subsection 2.2.3.1.1.1.

In order to determine the mass of natural gas release, the maximum release rate was determined. The release rate from a hole in a pipeline will vary over time; however for safety assessments, it is useful to calculate the maximum release rate of gas from the pipeline. A standard procedure for representing the maximum discharge is to represent the discharge through the pipe as an orifice. The orifice method always produces a larger value than the adiabatic or isothermal pipe methods, ensuring a conservative safety design.

Once it was verified that choke flow conditions would occur for a postulated break in the Florida Gas Transmission pipeline modeled, the maximum gas discharge rate from the break in the pipeline was calculated using the following equation which represents the release from the pipeline as an orifice.

$$Q_{max} = CAP_0\sqrt{\frac{\gamma g_c MW}{RT}\left(\frac{2}{\gamma+1}\right)^{\left(\frac{\gamma+1}{\gamma-1}\right)}} \qquad \text{(Equation 4)}$$

where

C = discharge coefficient (equals 1 for maximum case)
A = area of the hole, ft^2
g_c = gravitational constant, $ft \cdot lb_m/lb_f \cdot s^2$
MW = molecular weight, lb/lb_{mol}
R = ideal gas constant, $ft \cdot lb_f/lb_{mol} \cdot °R$
T = initial pipeline temperature, °R

Upon a complete pipeline rupture, the release rate of the gas (lb/s) will initially be very large, but within seconds the release rate will drop to a fraction of the initial release rate. Therefore, to estimate the amount of gas discharged for an instantaneous release, the maximum discharge rate was conservatively assumed to occur for a period of 5 seconds. This duration maintains the intent of the instantaneous detonation as applied in the TNT analysis—any longer and atmospheric dispersion effects will predominate resulting in a traveling vapor cloud—while maximizing the amount of gas released for the TNT analysis. This is also a conservative assumption given that the discharge rate will begin to

decrease significantly immediately after the break occurs. The amount of gas released was then determined by:

$$\text{Mass (lb)} = Q_{max}\ \text{(lb/s)} \times \text{time (s)} \qquad \text{(Equation 5)}$$

Using the flammable mass calculated by the above methodologies, the equivalent mass of TNT can be calculated using Equations 2 and 3.

The results indicate that the safe distance, the distance to 1 psi, is less than the minimum separation distance from the Unit 6 auxiliary building to the pipeline break (Table 2.2-213). The safe distance of 3097 feet is less than the minimum separation distance to the pipeline, 4535 feet. Therefore, the overpressure at the nearest safety related structure, the Unit 6 auxiliary building, resulting from an explosion due to immediate deflagration of natural gas vapor resulting from a pipeline rupture is not significant. The results indicate that overpressures from an explosion from a rupture in the Florida Gas Transmission Company Turkey Point Lateral natural gas transmission pipeline will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.2 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. When a flammable chemical is released into the atmosphere and forms a vapor cloud, it disperses as it travels 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. If the cloud burns fast enough to create a detonation, an explosive force is generated. The speed at which the flame front moves through the cloud determines whether it is considered a deflagration or a detonation. Two possible events are evaluated—thermal radiation effects from either a flash fire resulting from the ignition of a flammable vapor cloud or a jet fire resulting from the rapid release of gas from a pipeline, and pressure effects resulting from a vapor cloud explosion.

2.2.3.1.2.1 Flammable Vapor Cloud—Thermal Radiation

The onsite chemicals, Units 1 through 5 (Table 2.2-207) and Units 6 & 7 (Table 2.2-208); offsite chemical storage, Homestead Air Reserve Base, (Table 2.2-209); hazardous materials transported in pipelines, Turkey Point Lateral (Table 2.2-210); and hazardous materials potentially transported on roadways (Table 2.2-210), were evaluated to ascertain which hazardous materials

had the potential to form flammable vapor clouds. In each scenario, those chemicals with an identified flammability range, the ALOHA Version 5.4.1, air dispersion model 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 217). The safe distance for flammable vapor clouds was measured as the distance to the outer edge of the LFL section of the cloud.

Conservative assumptions were used in the ALOHA analyses regarding both meteorological inputs and identified scenarios (Tables 2.2-211 and 2.2-212). Each postulated event was evaluated under a spectrum of meteorological conditions to determine the worst-case meteorological condition. The spectrum of meteorological parameters chosen for the meteorological sensitivity analysis was selected based on the defined Pasquill meteorological stability classes (Table 2.2-212). The meteorological sensitivity analysis includes the most stable meteorological class, F, allowable with the ALOHA model. More stable meteorological classes and lower wind speeds will prevent a formed chemical vapor cloud from dispersing before reaching safety-related structures or the control room.

Other assumptions for the ALOHA model include:

- “Open Country” was selected for the ground roughness with the exception of those chemicals stored north of Units 1 through 4 (ammonium hydroxide); those chemicals stored at the PGS bulk gas storage area (hydrogen); and those chemicals stored inside the turbine building (hydrazine and morpholine), where “Urban or Forest” was selected. The degree of atmospheric turbulence influences how quickly a pollutant cloud moving downwind will mix with the air around it and will be diluted. Friction between the ground and air passing over it is one cause of atmospheric turbulence. The rougher the ground surface, the greater the ground roughness and the greater the turbulence that develops. A chemical cloud generally travels farther across open country than over an urban area or forest. The selection of “Open Country” is conservative because the Turkey Point site meets the criteria for “Urban or Forest”—an area with many friction-generating roughness elements, such as trees or small buildings (e.g., industrial areas). The site layout and location of the chemicals stored north of Units 1 through 4 and those stored at the PGS in relation to Units 6 & 7 would entail a vapor cloud travel through or around plant structures, thus “Urban or Forest” was selected for the determined worst-case meteorological conditions. In the case of the chemicals store inside the turbine building, the

formed vapor clouds would need to travel through various friction generating surface elements such as building components and a ventilation system, thus, “Urban or Forest” is the appropriate selection.

- The “Threat at Point” function was selected with no crosswind in the ALOHA modeling runs. This effectively models the chemical release as a direct-line source from the spill site to the point of concern, the nearest safety-related structure for Units 6 & 7. These results represent the worst-case hazard levels that could develop at that distance directly downwind of the source rather than accounting for the prevailing meteorological conditions.

- For each of the identified chemicals in the liquid state, it was conservatively assumed that the entire contents of the vessel leaked, forming a 1-centimeter-thick puddle. This provided a significant surface area from which to maximize evaporation and the formation of a vapor cloud.

- For each of the identified chemicals in the gaseous state, it was conservatively assumed that the quantity released from the vessel/pipeline is released over a 10-minute period into the atmosphere as a continuous direct source (40 CPR 68.25).

Guidance concerning flammable vapor clouds indicates that it is appropriate to consider the distance to the LFL as the safe distance for flammable vapor clouds. Generally, for flash fires the controlling factor for the amount of damage that a receptor will suffer is whether the receptor is physically within the burning cloud. This is because most flash fires do not burn very hot and the thermal radiation generated outside of the burning cloud will generally not cause significant damage due to the short duration (References 229 and 243). However, with the exception of those chemicals stored inside the turbine building, conservatively, the thermal radiation heat flux was calculated for each formed vapor cloud capable of ignition resulting in a flash fire. Those chemicals stored inside the turbine building were not evaluated because a fire in the turbine building does not affect safe shutdown capability. Fire areas located in the turbine building are separated from the safety-related areas of the nuclear island by a 3-hour fire barrier wall.

For this calculation, all of the mass of the vapor cloud is considered flammable and at the upper explosive limit. This is a conservative assumption because the upper explosive limit represents the highest percentage of fuel by volume in air (molar fraction) that can propagate a flame (Reference 215). The resulting incident heat flux on the nearest safety-related structure is calculated using the

following equation presented in the Society of Fire Protection Engineers Handbook of Fire Protection Engineering (Reference 221):

$$q = \frac{\bar{v} f \tau g^{1/2} \rho_f h_f V_f^{5/6}}{4\pi r^2}$$ (Equation 6)

Where,

q	=	incident heat flux, kW/m²
$\bar{v}$	=	normalized dimensionless heat transfer rate
f	=	fraction of combustion energy radiated to the environment
τ	=	atmospheric transmissivity
g	=	acceleration due to gravity, m/s²
ρ_f	=	vapor density, kg/m³
h_f	=	heat of combustion, kJ/kg
V_f	=	initial vapor volume of fuel, m³
r	=	the distance between the fireball center and the nearest safety-related structure, m—calculated as:

$$r = \left[x^2 + (Z - h)^2\right]^{1/2}$$ (Equation 7)

Where,

χ	=	horizontal separation of fireball center and nearest safety-related structure, m
Z	=	height of fireball center above ground, m
h	=	nearest safety-related structure height above ground, m

The following assumptions are used when calculating the radiant heat flux from a resulting flash fire:

- The temperature is assumed to be 40˚F, the mean extreme annual dry bulb temperature for nearby Homestead Air Reserve Base (Reference 222). This results in a conservative assumption as a lower ambient air temperature corresponds to a denser fuel upon release and thus a larger fuel mass.

- The initial vapor cloud before ignition is assumed to be spherical and located at the lower explosive limit distance away from the point of release—the

closest point that the vapor cloud can reach the nearest safety-related structure and still burn.

- The transmissivity of air is conservatively assumed to be one. This is conservative because the water vapor and carbon dioxide will absorb thermal radiation and depreciate the incident heat flux on the nearest safety-related structure. Making the assumption that the transmissivity of air is one results in neglecting those losses.

- The fraction of combustion energy radiated to the environment is assumed to be 20 percent (Reference 221).

- The normalized dimensionless heat transfer rate, $\overline{\nu}$ is assumed to be 0.0005, the point at which η, non-dimensionless time, becomes asymptotic (Reference 221).

- The nearest safety-related structure is conservatively assumed to be a blackbody—it absorbs all incident radiation.

- It is assumed that once the maximum fireball diameter and height are reached, they are maintained for the duration of the fireball.

2.2.3.1.2.2 Flammable Vapor Cloud—Explosions

Those identified chemicals with the potential to detonate are then evaluated to determine the possible effects of a flammable vapor cloud explosion. ALOHA was used to model the worst-case accidental vapor cloud explosion for the identified chemicals, including the safe distances and overpressure effects at the nearest safety-related structure. To model the worst-case vapor cloud explosion in ALOHA, detonation was chosen as the ignition source. The evaluation was conducted using the identical assumptions presented in Subsection 2.2.3.1.2.1 for the ALOHA model. The safe distance was measured as the distance from the spill site to the location where the pressure wave is at 1 psi overpressure.

The effects of flammable vapor clouds and vapor cloud explosions from internal and external sources are summarized in Table 2.2-214 and are described in following subsections relative to the release source.

2.2.3.1.2.3 Onsite Chemical Storage/Units 1 through 5

The hazardous materials stored on site 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 are acetylene, ammonium hydroxide, hydrazine, hydrogen, and propane. As described in Subsection 2.2.3.1.2.1, the ALOHA dispersion model was used to determine the distance a vapor cloud could 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 ammonium hydroxide, hydrazine, and liquid propane vessels leaked forming a one-centimeter-thick puddle; while, for acetylene and hydrogen, it was assumed that the entire contents of the tank are 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 Unit 6 auxiliary building. The distance to the LFL boundary for acetylene is 1308 feet; for ammonium hydroxide, 354 feet; for hydrazine, 42 feet; for hydrogen, 1032 feet; and for propane, the distance to the LFL boundary is 738 feet. Acetylene is stored approximately 4300 feet; ammonium hydroxide, approximately 5079 feet; hydrazine, approximately 2727 feet; hydrogen, approximately 3966 feet; and propane approximately 4168 feet from the Unit 6 auxiliary building (Table 2.2-214).

Further, as described in Subsection 2.2.3.1.2.1, the associated heat flux for each flammable vapor cloud was determined from the point at which the vapor cloud reaches the LFL to the nearest safety-related structure. The maximum incident heat flux for acetylene is 0.162 kW/m^2; for ammonium hydroxide, 0.900 kW/m^2; for hydrazine, 0.271 kW/m^2; for hydrogen, 0.033 kW/m^2 and for propane the maximum incident heat flux is 0.090 kW/m^2. These results are less than 5 kW/m^2 level of concern defined by the EPA.

A vapor cloud explosion analysis was also completed following the methodology as detailed in Subsection 2.2.3.1.2.2 in order to obtain safe distances. The results concluded that the safe distance, the minimum distance required for an explosion to have less than a 1 psi peak incident pressure, are less than the shortest distance to the nearest safety-related structure for Units 6 & 7, the Unit 6 auxiliary building, and the storage location of these chemicals. The safe distance for the acetylene cylinders is 1764 feet; for ammonium hydroxide, 963 feet; for one hydrogen tube trailer, 1182 feet; and for liquid propane, 1416 feet. For hydrazine, no explosion occurs because the vapor pressure for hydrazine is sufficiently low 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 from the nearest safety-related structure than the calculated safe distance.

Therefore, a flammable vapor cloud with the possibility of ignition or explosion formed from the onsite chemical storage for Units 1 through 5 analyzed will not adversely affect the safe operation or shutdown of Units 6 & 7 (Table 2.2-214).

2.2.3.1.2.4 Onsite Chemical Storage/Units 6 & 7

The hazardous materials stored on site 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 are methanol, hydrazine, morpholine, and hydrogen. As described in Subsection 2.2.3.1.2.1, the ALOHA dispersion model was used to determine the distance a vapor cloud could travel to reach the LFL boundary once a vapor cloud has formed from an accidental release of the identified chemical. Because hydrazine and morpholine are located inside the turbine building in a room with curbing, it was conservatively assumed that the entire contents of the largest vessel for each identified scenario leaked forming a puddle with the same area as the bermed area of the chemical storage room. Further, for the chemicals located inside the turbine building, the vapor cloud explosion analyses were conservatively modeled as if no building is present. For the hydrogen storage banks, the analyzed quantity was 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 Unit 6 auxiliary building. The distance to the LFL boundary for methanol is 282 feet; for hydrazine, less than 33 feet; for morpholine, less than 33 feet; and for hydrogen, 507 feet. Methanol is stored at the FPL reclaimed water treatment facility approximately 5581 feet; hydrazine and morpholine are stored approximately 218 feet; and hydrogen is stored approximately 560 feet from the nearest safety-related structure—either the Unit 6 or Unit 7 auxiliary building (Table 2.2-214).

Further, as described in Subsection 2.2.3.1.2.1, for those chemicals stored outside the turbine building, the associated heat flux for each flammable vapor cloud was determined from the point at which the vapor cloud reaches the LFL to the nearest safety-related structure. The maximum incident heat flux for methanol is 0.592 kW/m^2; and for hydrogen is 2.344 kW/m^2. These results are less than 5 kW/m^2 level of concern defined by the EPA.

A vapor cloud explosion analysis was also completed as detailed in Subsection 2.2.3.1.2.2 to obtain safe distances. The results concluded that the safe distance, the minimum distance required for an explosion to have less than a 1 psi peak incident pressure, are less than the shortest distance to the nearest safety-related structure for Units 6 & 7, the Unit 6 auxiliary building, and the storage location of these chemicals. The safe distance for the methanol is 804 feet; for hydrazine, no detonation; for morpholine, no detonation; and for hydrogen, 432 feet. For hydrazine and morpholine, no detonation/explosion occurs because the vapor pressures are sufficiently low 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 from the nearest safety-related structure than the calculated safe distance. Therefore, a flammable vapor cloud with the possibility of ignition or explosion formed from the storage of the onsite chemical storage for Units 6 & 7 analyzed will not adversely affect the safe operation or shutdown of Units 6 & 7 (Table 2.2-214).

2.2.3.1.2.5 Nearby Facilities/Homestead Air Reserve Base

The Homestead Air Reserve Base, located approximately 4.76 miles, 25,133 feet, from the nearest safety-related structure, the Unit 6 auxiliary building, operates within the vicinity of the Turkey Point site. The hazardous materials stored at Homestead Air Reserve Base that were identified for further analysis with regard to the potential for delayed ignition of a flammable vapor cloud formed following the accidental release of a hazardous material are gasoline and propane. For gasoline, it was conservatively assumed that the entire contents of the vessel leaked and formed a 1-centimeter-thick puddle. Because solutions such as gasoline cannot be modeled in the current version of ALOHA, as recommended by the EPA, gasoline was modeled for flammable vapor cloud and vapor cloud explosion analysis by selecting n-Heptane as a surrogate for gasoline in ALOHA's chemical library. This selection is appropriate as the evaporation curves over a range of temperatures for n-Heptane and gasoline are shown to be similar, and at temperatures below 80°C, the evaporation of n-Heptane occurred at a faster rate (Reference 246). In the case of propane, the entire contents of the tank are assumed to be released over a 10-minute period as a continuous direct source. The results using the methodology described in Subsection 2.2.3.1.2.1 concluded that any plausible vapor cloud that could form and mix sufficiently under stable atmospheric conditions is below the LFL boundary before reaching the Units 6 & 7 site (Table 2.2-214). The greatest distance to the LFL boundary, 2190 feet, was for propane, while the distance to the LFL boundary for gasoline was 678 feet.

Further, as described in Subsection 2.2.3.1.2.1, the associated heat flux for each flammable vapor cloud was determined from the point at which the vapor cloud reaches the LFL to the nearest safety-related structure. The maximum incident heat flux for gasoline is 0.051 kW/m^2; and for propane the maximum incident heat flux is 0.078 kW/m^2. These results are less than 5 kW/m^2 level of concern defined by the EPA (Table 2.2-214).

Because each of the identified chemicals has the potential to explode, a vapor cloud explosion analysis was also performed as described in Subsection 2.2.3.1.2.2. The results of the vapor cloud explosion analysis concluded that the safe distance, the minimum distance required for an explosion to have less than a 1 psi peak incident pressure, is less than the minimum separation distance between the Unit 6 auxiliary building and the release point at Homestead Air Reserve Base. The largest determined safe distance was for propane, 4866 feet, while the determined safe distance for gasoline was 1623 feet. (Table 2.2-214)

Therefore, a flammable vapor cloud with the possibility of ignition or explosion from the storage of chemicals at offsite facilities will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.2.6 Transportation Routes/Roadways

The nearest safety-related structure for Units 6 & 7, the Unit 6 auxiliary building, is located approximately 2054 feet at its closest point of approach from the onsite transportation delivery route for gasoline. The methodology presented in Subsection 2.2.3.1.2.1 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, 9000 gallons, of gasoline. The results for the 9000-gallon gasoline tanker concluded 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 nearest safety-related structure. The distance to the LFL boundary for gasoline is 402 feet.

Further, as described in Subsection 2.2.3.1.2.1, the associated heat flux for the formed flammable vapor cloud was determined from the point at which the vapor cloud reaches the LFL to the nearest safety-related structure. The maximum incident heat flux for the 9000-gallon gasoline tanker is 2.776 kW/m^2. These results are less than 5 kW/m^2 level of concern defined by the EPA.

Gasoline was also evaluated using the methodology presented in Subsection 2.2.3.1.2.2 to determine the effects of a possible vapor cloud explosion. The safe distance, the minimum separation distance required for an explosion to have less than a 1 psi peak incident pressure impact from the drifted gasoline vapor cloud, is less than the shortest distance to the onsite gasoline delivery route. The safe distance for this quantity of gasoline was determined to be 1014 feet (Table 2.2-214).

Therefore, a flammable vapor cloud ignition or explosion from a 9000-gallon gasoline tanker transported on site will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.2.7 Transportation Routes/Pipelines

The Florida Gas Transmission Company owns and operates a high-pressure natural gas transmission pipeline system that serves FPL within the vicinity of Units 6 & 7. At its closest distance, the Turkey Point Lateral pipeline passes within approximately 4535 feet of the nearest safety-related structure for Units 6 & 7—the Unit 6 auxiliary building. 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. Two scenarios were considered for the postulated natural gas pipeline rupture. The first scenario considered a formed vapor cloud that traveled toward Units 6 & 7. As the vapor cloud travels towards Units 6 & 7, it is plausible that the cloud concentration could become flammable along its path. As described in Subsection 2.2.3.1.2.1, the ALOHA dispersion model was used to determine the distance a vapor cloud could travel to reach the LFL boundary once a vapor cloud has formed from an accidental release of natural gas (as methane) from the pipeline. The pipeline release source module was selected in the ALOHA program to model the natural gas release. The pipeline characteristics presented in Table 2.2-204 and the gas pipeline temperature for the Turkey Point Lateral, 78°F, are used as inputs to the ALOHA model. It was conservatively assumed that the pipeline was “connected to an infinite tank source” and that the roughness of the pipeline was “smooth” to model the break. The results concluded that under this scenario, the plausible vapor cloud that could form will be below the LFL boundary before reaching the nearest safety related structure for Units 6 & 7—the Unit 6 auxiliary building.

Because of the possibility that the natural gas vapor cloud may become confined either outside or by migration inside a building, a vapor cloud explosion analysis

was performed as described in Subsection 2.2.3.1.2.2 and the ALOHA pipeline inputs from the preceding paragraph. The results of the vapor cloud explosion analysis concluded that the safe distance, the minimum distance required for an explosion to have less than 1 psi peak incident pressure, of 3033 feet, is less than the separation distance, 4535 feet, between the Unit 6 auxiliary building and the pipeline break.

As described in Subsection 2.2.3.1.1.7, when leaked natural gas is not trapped and immediate ignition occurs, a jet fire will develop. A jet fire occurs when a flammable chemical is rapidly released from an opening in a vessel or pipeline and an immediate ignition occurs. The jet fire stabilizes to a point that is close to the source of the release and continues to burn until the fuel source is stopped. Thus, the jet fire scenario should be considered for determining safety distances in the vicinity of natural gas pipelines. This is because in addition to producing thermal radiation, the jet fire causes considerable convective heating in the region beyond the flame tip. Additionally, the high velocity of the escaping gas into the jet causes more efficient combustion to occur than in pool fires. Therefore a much higher heat transfer rate could occur for a jet fire than in a pool fire flame.

The safe distance for a jet fire is measured as the distance from the fire to the point where the thermal heat flux reaches 5.0 kW/m^2. For the natural gas pipeline, ALOHA was used to model the worst-case accidental release from a pipeline resulting in a jet fire, including the safe distances and thermal heat flux effects on the nearest safety related structure.

The thermal effect of a jet fire strongly depends on atmospheric conditions and the impact radius for thermal radiation is primarily affected by wind speed, and increases with decreasing wind speed. Thermal radiation is also affected by atmospheric transmittivity. Atmospheric transmittivity is the measure of how much thermal radiation from a fire is absorbed and scattered by water vapor and other components in the atmosphere. To model the jet fire scenario in ALOHA, the worst case meteorological conditions determined from the vapor cloud flammability and explosion analyses for the pipeline was used as site atmospheric input for the jet fire analysis. Because humidity is used to determine the atmospheric transmittivity in the ALOHA model, the humidity levels were varied to determine the atmospheric worst case in ALOHA for the jet fire scenario. The results of the jet fire analysis concluded that the safe distance, the distance to 5 kW/m^2, of 1035 feet, is less than the separation distance, 4535 feet, between the Unit 6 auxiliary building and the pipeline break. The maximum thermal radiation effects at the nearest safety related structure for modeled jet fire scenario is 0.261 kW/m^2.

Therefore, a jet fire or flammable vapor cloud ignition or explosion from a rupture in the Turkey Point Lateral natural gas transmission pipeline will not adversely affect the safe operation or shutdown of Units 6 & 7 (Table 2.2-214).

2.2.3.1.3 Toxic Chemicals

Accidents involving the release of toxic or asphyxiating chemicals from onsite storage facilities and nearby mobile and stationary sources were considered. Toxic chemicals known to be present on site or in the vicinity of the Turkey Point site, or to be frequently transported in the vicinity, were evaluated.

The onsite chemicals, Units 1 through 5 (Table 2.2-207) and Units 6 & 7 (Table 2.2-208); offsite chemical storage, Homestead Air Reserve Base, (Table 2.2-209); hazardous materials transported in pipelines, Turkey Point Lateral (Table 2.2-210); and hazardous materials potentially transported on roadways (Table 2.2-210) were evaluated to ascertain which hazardous materials should be analyzed with respect to their potential to form a toxic or asphyxiating vapor cloud following an accidental release.

The ALOHA air dispersion model was used to predict the concentrations of toxic or asphyxiating chemical clouds as they disperse downwind for all facilities and sources except for the Turkey Point Lateral natural gas pipeline. In the case of a toxic vapor cloud, the maximum distance a cloud can travel before it disperses enough to fall below the *Immediately Dangerous to Life and Health* (IDLH) or other determined toxicity limit concentration in the vapor cloud was determined using ALOHA. Asphyxiating chemicals were evaluated to determine if their release resulted in the displacement of a significant fraction of the control room air—defined by the Occupational Safety and Health Administration's (OSHA) definition of an oxygen-deficient atmosphere.)

The IDLH is defined by the National Institute of Occupational Safety and Health (NIOSH) as a situation that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects, or prevent escape from such an environment. The IDLHs are determined by NIOSH so 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 or threshold limit value, promulgated by OSHA or adopted by the American Conference of Governmental Hygienists, was used as the toxicity concentration level.

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. ALOHA is a diffusion model that permits temporal as well as spatial variations in release terms and concentrations in the control room. The concentrations in the control room are limited to a 60-minute period because, as indicated in RG 1.78, the probability of a plume remaining within a given sector for a long period of time is quite small.

The toxicity/asphyxiation analyses conducted using the ALOHA model was run under a spectrum of standard meteorological conditions (selected stability class, wind speed, time of day, and cloud cover) based on the defined Pasquill meteorological stability classes (Tables 2.2-211 and 2.2-212). The meteorological sensitivity analysis includes the most stable meteorological class, F, allowable with the ALOHA model. The more stable the meteorological class and the lower the wind speed, the less turbulence is generated, and therefore less mixing and dilution of the formed pollutant cloud should occur.

Other atmospheric inputs/assumptions for the ALOHA model include:

- “Open Country” was selected for the ground roughness with the exception of those chemicals stored north of Units 1 through 4 (ammonium hydroxide and sodium hypochlorite); those chemicals stored at the PGS bulk gas storage area (nitrogen, hydrogen, and carbon dioxide); the sodium hypochlorite stored at the Cooling Towers; and those chemicals stored inside the turbine building (hydrazine, morpholine, and sodium hypochlorite), where “Urban or Forest” was selected. The degree of atmospheric turbulence influences how quickly a pollutant cloud moving downwind will mix with the air around it and will be diluted. Friction between the ground and air passing over it is one cause of atmospheric turbulence. The rougher the ground surface, the greater the ground roughness and the greater the turbulence that develops. A chemical cloud generally travels farther across open country than over an urban area or forest. The selection of “Open Country” is conservative because the Turkey Point site meets the criteria for “Urban or Forest”—an area with many friction-generating roughness elements, such as trees or small buildings (e.g., industrial areas). The site layout and location of the chemicals stored north of Units 1 through 4 and those stored at the PGS and the Cooling Tower Area in relation to Units 6 & 7 would entail a vapor cloud travel through or around plant structures, thus “Urban or Forest” was selected for the determined worst-case meteorological conditions. In the case of the chemicals stored inside the

turbine building, the formed vapor clouds would need to travel through various friction generating surface elements such as building components and a ventilation system, thus, “Urban or Forest” is the appropriate selection.

- The “Threat at Point” function was selected with no crosswind for the ALOHA modeling runs. This selection effectively models the chemical release as a direct-line source from the spill site to the point of concern, the control room intake. This is conservative because all of the chemicals, with the exception of the onsite chemicals associated with Units 6 & 7, are stored to the north of Units 6 & 7, and the predominant annual wind direction is from the east with an annual frequency of approximately 17 percent—and when deriving the toxicity level in the control room, RG 1.78 provides an allowance for taking into account the prevailing meteorological conditions at the site.

- Except for those chemicals stored inside the turbine building, for each of the identified chemicals, it was conservatively assumed that the entire contents of the vessel leaked, forming a 1-centimeter-thick puddle.

- For those identified hazardous materials in the gaseous state, it was conservatively assumed that the entire contents of the vessel or pipeline are released over a 10-minute period into the atmosphere as a continuous direct source (40 CFR 68.25).

- Chemicals located inside the turbine building were modeled based on indoor release rates. This method provides a more realistic approach for determining the toxic chemical concentration in the control room - the evaporation rate of a liquid may be much lower inside a building than outside. (Reference 220)

  The evaporation rate is calculated as follows (Reference 220):

$$QR = U^{0.78} \cdot LFA \cdot A$$

  Where,

  QR = Release rate (pounds per minute (lbs/min))
  U = Wind speed (meters per second (m/s)) - conservatively assumed to be 0.1 m/s
  LFA = Liquid Factor Ambient
  A = Area of pool (square feet (ft^2))

The LFA value, developed for all toxic and flammable regulated liquids, is determined by equation (Reference 220).

$$LFA = \frac{0.284 \cdot MW^{2/3} \cdot VP}{82.05 \cdot 298}$$

Once an indoor release rate was determined, the release was modeled as a direct source over a 60 minute period as if the building/structure did not exist.

- In order to model sodium hypochlorite, first the partial vapor pressure was determined as (Reference 220):

  $VP_m = X_r * (\text{Vapor pressure of a pure substance})$

  Once the partial vapor pressure was determined, the evaporation rate for sodium hypochlorite solution was calculated as (Reference 220):

$$QR = \frac{0.0035 * U^{0.78} * MW^{2/3} * A * VP}{T}$$

  Where,

  QR = Evaporation rate (pounds per minute (lbs/min))
  U = Wind speed (meters per second (m/s))
  MW = Molecular weight
  A = Surface area of pool formed by entire quantity of mixture (square feet (ft^2))
  VP = Vapor pressure (mmHg)
  T = Temperature of released substance (Kelvin (K))

  Because sodium hypochlorite has to be modeled as a direct source, a virtual point method was applied to account for the point source release. Note, the virtual point correction was not applied for sodium hypochlorite in the turbine building because the spill would occur in a dike area.

The effects of toxic chemical releases from internal and external sources are summarized in Table 2.2-215 and are described in the following subsections relative to the release sources.

2.2.3.1.3.1 Onsite Chemical Storage/Units 1 through 5

The hazardous materials stored onsite that were identified for further analysis with regard to the potential of the formation of toxic vapor clouds formed following an accidental release are acetylene (asphyxiant), ammonium hydroxide, argon (asphyxiant), carbon dioxide, chlorine, hydrazine, hydrogen (asphyxiant), muriatic acid, nitrogen gas (asphyxiant), liquid nitrogen (asphyxiant), oxygen (may create an oxygen enriched environment), propane, and sodium hypochlorite. As described in Subsection 2.2.3.1.3, 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 may reach in the control room following an accidental release. Acetylene, argon, carbon dioxide, chlorine, hydrogen, nitrogen, and oxygen concentrations were determined at the control room following a 10-minute release from the largest storage vessel. For each chemical in the liquid phase (ammonium hydroxide, hydrazine, muriatic acid, liquid nitrogen, propane, and sodium hypochlorite), the worst-case release scenario in each of the analyses included the total loss of the largest vessel, resulting in an unconfined 1-centimeter-thick puddle. In the case of each of the asphyxiants or toxic gases, the maximum concentration, under the determined worst-case meteorological conditions, at the control room—157 parts per million (ppm) acetylene, 299 parts per minute (ppm) argon, 321 ppm carbon dioxide, 1.68 ppm chlorine, 185 ppm hydrogen, 500 ppm nitrogen, 340 ppm liquid nitrogen, and 34.8 ppm oxygen—would not displace enough oxygen for the control room to become an oxygen-deficient environment, or in the case of an oxygen release, an oxygen-enriched environment, nor would they be otherwise toxic at these concentrations. Consistent with RG 1.78, asphyxiating chemicals should be considered if their release results in a displacement of a significant fraction of control room air—in accordance with the definition of oxygen-deficient atmosphere provided by the OSHA. (Reference 230) The remaining chemical analyses concluded that the control room will remain habitable for the determined worst-case release scenario—253 ppm ammonium hydroxide (urban), 14.1 ppm hydrazine, 2.13 ppm muriatic acid, 26.2 ppm propane, and 0.327 ppm sodium hypochlorite (urban). (Table 2.2-215) Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials stored on site will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.3.2 Onsite Chemical Storage/Units 6 & 7

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 are methanol, sodium hypochlorite (storage at FPL reclaimed water treatment facility, cooling tower, and the turbine building), hydrazine, morpholine, liquid nitrogen (asphyxiant), nitrogen (asphyxiant), hydrogen (asphyxiant), liquid carbon dioxide, and carbon dioxide. As described in Subsection 2.2.3.1.3, 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 may reach in the control room following an accidental release. Liquid carbon dioxide, carbon dioxide, hydrogen, and nitrogen concentrations were determined at the control room following a 10-minute release from the largest storage vessel. For each chemical stored in the turbine building in the liquid phase (hydrazine, morpholine, and sodium hypochlorite) each of the analyses included the total loss of the largest vessel, resulting in a puddle release whose area is equivalent to the bermed area in the chemical storage room in the turbine building. For remaining chemicals stored in the liquid phase, the worst-case release scenario included the total loss of the largest vessel, resulting in an unconfined 1-centimeter-thick puddle. In the case of each of the asphyxiants or toxic gases, the concentration under the determined worst-case meteorological conditions at the control room—4980 ppm carbon dioxide, 5130 ppm liquid carbon dioxide, 1890 ppm hydrogen, 1310 ppm nitrogen, and 2160 ppm liquid nitrogen—would not displace enough oxygen for the control room to become oxygen-deficient, nor would they be otherwise toxic at these concentrations. The remaining chemical analyses indicate that the control room would remain habitable for the determined worst-case release scenario—128 ppm methanol, 40.7 ppm hydrazine, 9.96 ppm morpholine, 2.68 ppm sodium hypochlorite (FPL reclaimed water treatment facility), 5.59 ppm sodium hypochlorite (cooling tower), and 1.15 ppm sodium hypochlorite (turbine building) (Table 2.2-215). Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials stored on site would not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.3.3 Nearby Facilities/Homestead Air Reserve Base

The Homestead Air Reserve Base is approximately 4.76 miles, 25,133 feet, from the Turkey Point site. The hazardous materials stored at Homestead Air Reserve Base that are 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 are Halon 1301, oxygen (potential for creating an oxygen enriched environment), gasoline, and propane. For Halon 1301 and gasoline, the worst-case release scenario included the total loss of the largest vessel, resulting

in an unconfined 1-centimeter-thick puddle. Because solutions such as gasoline cannot be modeled in the current version of ALOHA as recommended by the EPA, gasoline was modeled for toxicity analysis by selecting n-Heptane as a surrogate for gasoline in ALOHA's chemical library. This selection is appropriate as the evaporation curves over a range of temperatures for n-Heptane and gasoline are shown to be similar, and at temperatures below 80°C, the evaporation of n-Heptane occurred at a faster rate (Reference 246). Oxygen and Propane concentrations are determined outside the control room following a 10-minute release of the total quantity onsite. In the case of oxygen, the maximum concentration under the determined worst-case meteorological condition at the control room—9.39 ppm—would not displace enough air for the control room to become an oxygen enriched environment. The chemical analysis indicates that the distance the Halon 1301, gasoline, or propane vapor cloud could travel before falling below the selected toxicity limit was less than the distance to the control room for each meteorological condition analyzed (Table 2.2-215). Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials stored at an offsite facility will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.3.4 Transportation Routes/Roadways

The nearest control room for Units 6 & 7 is approximately 2084 feet at its closest point of approach, from the onsite transportation delivery route for gasoline. As detailed in Subsection 2.2.2.5, delivery of chemicals other than gasoline to the Units 1 through 5 site are screened and determined to be bounded by the evaluation performed for the Units 1 through 5 onsite storage quantities. The methodology presented in Subsection 2.2.3.1.3 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 time-weighted average toxicity limit was conservatively used because no IDLH is available for this hazardous material. The time-weighted average is the average value of exposure over the course of an 8-hour work shift. Gasoline was modeled for toxic analysis by selecting n-Heptane in ALOHA's chemical library. 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 concluded that any vapor cloud that forms following an accidental release of gasoline at the closest approach from the onsite transportation delivery route, and travels toward the control room, will not achieve an airborne concentration greater than the time-weighted average in the control room (Table 2.2-215). Therefore, the

formation of a toxic vapor cloud following an accidental release of gasoline transported onsite will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.3.5 Transportation Routes/Pipelines

The Florida Gas Transmission Company owns and operates a high pressure natural gas transmission pipeline system that serves FPL. At its closest distance, the Turkey Point Lateral pipeline passes within approximately 4535 feet of the nearest control room for Units 6 & 7, the Unit 6 control room. Natural gas or its main constituent, methane, is not considered toxic and there is no IDLH or other toxicity limit identified. However, natural gas is considered an asphyxiant. Therefore, an analysis is necessary for the natural gas transmission pipeline to determine whether an oxygen-deficient environment exists in the control room from the displacement of air. Utilizing the methodology and inputs described in Subsections 2.2.3.1.3 and 2.2.3.1.2.7, natural gas (as methane) was analyzed using the ALOHA dispersion model to determine whether the formed vapor cloud would reach the control room intake and whether the concentration of the asphyxiating chemical may reach levels in the control room which would displace enough oxygen. The concentration under the determined worst-case meteorological conditions at the control room—855 ppm—will not displace enough oxygen for the control room to become an oxygen-deficient atmosphere.

2.2.3.1.4 Fires

Accidents were considered in the vicinity of the Turkey Point site 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—are evaluated as events that could lead to high heat fluxes or to the formation of such clouds.

The nearest industrial site is the Homestead Air Reserve Base, located approximately 4.76 miles from Units 6 & 7. Each of the chemicals stored at Units 1 through 7 and the Homestead Air Reserve Base along with the nearest natural gas transmission pipeline, the Turkey Point Lateral, are evaluated in Subsection 2.2.3.1.2 for potential effects, including heat fluxes where appropriate, 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 concluded that any formed vapor cloud will dissipate below the LFL before reaching the control room. Further, an evaluation of the heat flux from the

formed vapor cloud capable of ignition concluded that the resulting heat flux from a flash fire or jet fire (Florida Gas Transmission pipeline) will be below the 5 kW/m^2 threshold (Table 2.2-214). Therefore, it is not expected that there will be any hazardous effects to Units 6 & 7 from fires or heat fluxes associated with the operations at these facilities, transportation routes, or pipelines.

Further, the potential for an onsite fire from the residual fuel oil storage facilities located at the Turkey Point site was evaluated to estimate the resulting heat flux. Subsection 2.2.3.1.2 does not include an evaluation of the heat flux from the formation of a vapor cloud because the low vapor pressure of residual fuel oil makes this a non-credible event. The incident heat flux was calculated using the solid flame model presented in NUREG-1805. The solid flame model is based on the assumption that the fire is a solid vertical cylinder that emits thermal radiation laterally. The incident heat flux calculated from the solid flame model requires that the average emissive power at the flame surface (kW/m^2) and the configuration factor along with the flame height be calculated. The methodology used to calculate the average emissive power, flame height, configuration factor and resultant incident heat flux is as follows:

Emissive Power

The emissive power (E) is the total surface radiation of the fire per unit area per unit time (NUREG-1805).

$$E(kW/m^2) = 58\ (10^{-0.00823D}) \qquad \text{(Equation 8)}$$

Where, D is the effective diameter of the pool fire for a noncircular pool and is calculated from the surface area of the pool (A_f) and is given by the following equation:

$$D = (4A_f/\pi)^{1/2} \qquad \text{(Equation 9)}$$

Flame Height

For open pool burning with no fire growth, the following correlation can be used to determine the flame height of the fire (NUREG-1805).

$$H_f(m) = 0.235\ Q^{0.4} - 1.02\ D \qquad \text{(Equation 10)}$$

Where, D is the effective diameter of the fire (m) and Q is the heat release of the fire determined by the following relationship:

$$Q = m^n\ \Delta H_{c,eff}\ A_f\ (1-e^{-k\beta D}) \qquad \text{(Equation 11)}$$

Where, m^n is the mass loss rate per unit area per unit time (kg/m^2-s); $\Delta H_{c,\,eff}$ is the heat of combustion (kJ/kg); A_f is the surface area of the pool (m^2); and kβ is an empirical constant (m^{-1}).

Configuration Factor

The configuration factor (F_{1-2}) is a geometric quantity that accounts for the fraction of the radiation leaving one surface that strikes another surface directly. The configuration factor is a sum of the horizontal and vertical vectors and is a value between 0 and 1. The factor approaches 1 as the distance between the point of interest and the flame is decreased (NUREG-1805).

$$F_{1-2} = (F^2_{1-2,H} + F^2_{1-2,V})^{1/2} \qquad \text{(Equation 12)}$$

Incident Heat Flux

The incident heat flux, Q''_{inc}, to the target is given by (NUREG-1805):

$$Q''_{inc}\ (\text{kW/m}^2) = EF_{1-2} \qquad \text{(Equation 13)}$$

The following inputs and assumptions were used in determining the incident heat flux:

- It was conservatively assumed that the entire contents of one of the residual fuel oil storage tanks, 268,000 barrels, completely ruptures spilling the entire contents into the bermed area.
- The terrain between the fire and the closest plant structure is assumed to be flat with no obstructions.
- It is assumed that it is an open pool fire and the entire surface of the fuel oil in the bermed area is involved. The pool is assumed to be circular with an area equivalent to the bermed area.
- The fire is assumed to be a perfect black body with an emissivity of 1.
- The transmissivity of air is assumed to be 1—this assumes that no thermal radiation is absorbed by air.
- The Unit 6 service building, located 3668 feet from the postulated fuel oil fire, was conservatively used as the separation distance between the fire and nearest building—although the service building is not a safety-related

structure, it was conservatively chosen as the structure of concern for Units 6 & 7.

Using the method described above the incident heat flux for a postulated pool fire involving the entire contents of the storage vessel would result in an incident heat flux of 0.0625 kW/m^2 at the Unit 6 service building—below the selected 5.0 kW/m^2 level of concern for heat from fires. Further, a dispersion analysis study concluded that airborne pollutant concentration levels resulting from the postulated fire will be below established ambient air quality standards before reaching Units 6 & 7.

Brush and forest fires were also considered consistent with RG 1.206. Units 6 & 7 are built on fill material to an elevation of approximately 25-26 feet NAVD 88. The plant area consists of approximately 218 acres providing a cleared area consisting of limited vegetative fuel for a fire of at least 600 feet wide surrounding the Units 6 & 7 site safety-related structures. This provides a substantial defensible zone in the unlikely event of a fire originating as a result of onsite or offsite activities. Additionally, Units 6 & 7 is located south of Units 1 through 5 and are within the cooling canals. These canals, which are approximately 100–150 feet wide, encircle the Units 6 & 7 plant area. The canals are deep, primary return, water canals leading to Units 1 through 4 cooling water intakes. Therefore, the zone surrounding Units 6 & 7 is of sufficient size, especially when considering the canals surrounding the plant area, to afford protection in the event of a fire. The Florida Department of Agriculture and Consumer Services, Division of Forestry recommends a defensible space of 30 feet (minimum) to 100 to 200 feet be maintained around structures for protection against wildfires. In addition, California has adopted regulations requiring a fire break of at least 30 feet and a fuel break to 100 feet (References 231 and 232). The safety zone around Units 6 & 7 greatly exceeds these recommended distances, and therefore, it is not expected that there will be any hazardous effects to Units 6 & 7 from fires or heat fluxes associated with wild fires, fires in adjacent industrial plants, or from onsite storage facilities.

2.2.3.1.5 Collisions with Intake Structure

Because Units 6 & 7 are located near a navigable waterway, an evaluation was performed that considered the probability and potential effects of impacts on the plant cooling water intake structure and enclosed pumps. The Units 6 & 7 makeup water system consists of either reclaimed water provided from the Miami-Dade Water and Sewer Department or saltwater makeup water from the radial collector wells to the circulating water cooling system. The radial collector wells consist of a central

reinforced concrete caisson, extending below the Biscayne Bay seabed. The wells are designed to induce infiltration from the nearby surface water source (Biscayne Bay), combining the desirable features of extremely high well yields with induced seabed filtration of suspended particulates. Thus, there is no intake structure associated with either the reclaimed water pipeline or radial collector well system that would be damaged as a result of navigable waterway activities that would affect the safe shutdown of Units 6 & 7.

2.2.3.1.6 Liquid Spills

The accidental release of oil or liquids that may be corrosive, cryogenic, or coagulant was 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 Biscayne Bay, they would not only be diluted by the large quantity of Biscayne Bay water, but the only material shipped by barge, residual fuel oil, has a specific gravity less than water and would float on top of the water. Therefore, any spill in the Biscayne Bay will not affect the water supplied by the radial collector wells and will not affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.6.1 Radiological Hazards

The hazard due to the release of radioactive material from Units 3 & 4 as a result of normal operations or an unanticipated event will not threaten safety of the new units. Smoke detectors, radiation detectors, and associated control equipment are installed at various plant locations as necessary to provide the appropriate operation of the systems. Radiation monitoring of the main control room environment is provided by the radiation monitoring system. The habitability systems for Units 6 & 7 are capable of maintaining the main control room environment suitable for prolonged occupancy throughout the duration of the postulated accidents that require protection from external fire, smoke, and airborne radioactivity. Automatic actuation of the individual systems that perform a habitability systems function is provided. In addition, safety-related structures, systems, and components for Units 6 & 7 have been designed to withstand the effects of radiological events and the consequential releases which will bound the contamination from a release from either of these potential sources.

2.2.3.2 Effects of Design Basis Events

As concluded in the previous subsections, no events were identified that had a probability of occurrence on the order of magnitude of 1E-07 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. Thus, there are no accidents associated with nearby industrial, transportation, or military facilities that are considered design basis events.

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2.2.4 COMBINED LICENSE INFORMATION

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This COL item is addressed in Subsections 2.2 through 2.2.3.

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Table 2.2-201
Description of Facilities — Products and Materials

Site	Concise Description	Primary Function	Number of Persons Employed	Major Products or Materials
Units 1 through 5	Units 1 & 2 are gas/oil-fired steam electric generating units; Units 3 & 4 are nuclear powered steam electric generating units; and Unit 5 is a natural gas combined-cycle plant.	Power Production	977	Electrical Power
Homestead Air Reserve Base	Homestead Air Reserve Base is a fully combat-ready unit capable of providing F-16C multipurpose fighter aircraft, along with mission ready pilots and support personnel, for short-notice worldwide deployment.	Military Installation	2365	N/A — Military Installation

Source: References 201, 202, and 203

PTN COL 2.2-1

Table 2.2-202 (Sheet 1 of 5)
Onsite Chemical Storage Units 1 through 7

Material	Toxicity Limit IDLH[(a)]	Maximum Quantity in Largest Container	Primary Storage Location
Units 1 through 5			
Acetylene Gas	Asphyxiant	150 pound cylinders (3,000 pounds total)	Welding Gas House
Ammonium Hydroxide	300 ppm	(2) 20,000 gallon above ground storage tanks	East Side Unit 5 for SCR
Argon Gas	Asphyxiant	150 pound cylinders (3,000 pounds total)	Welding Gas House
Boric Acid	None Established	Fiber drums (66,660 pounds total)	Units 3 & 4 Central Receiving Warehouse/ Boric Acid Room
Carbon Dioxide	40,000 ppm	150 pound cylinders (9,000 pounds total)	Compressed Gas House
Chlorine	10 ppm	150 pound cylinder	Nuclear Sewage Treatment Area
Citric Acid	None Established	500 pounds	Water Treatment Area (Units 1 & 2)
Hydrated Lime (Calcium Hydroxide)	5 mg/m^3[(b)]	35,000 pounds	Fossils Storage Building
Hydrazine	50 ppm	1,100 gallons (2,215 gallons total)	Stores Drum Storage Area (Units 3 & 4)
Hydrogen Gas	Asphyxiant	(2) 45,000 standard cubic feet (2 Hydrogen Tube Trailers)	Stored in two Hydrogen Tube Trailers
Hydrogen Peroxide	75 ppm	5 gallon	Primary Chemical Addition Area
Lead (in battery)	100 mg/m^3 (as lead)	174,000 pounds	Units 1 through 5 Battery Rooms/Land Utilization Fleet Service Shop
Lithium Hydroxide	None Established	5 gallons	Primary Chemical Addition Area
Lube Oil	None Established	14,800 gallon storage tank (122,548 gallons total)	Units 3 & 4 Lube Oil Storage Tank/Lube Oil Reservoirs
Magnesium Oxide	750 mg/m^3	20,000 pounds	Fossils Storage Building
Mineral Oil	2,500 mg/m^3	(2) 16,180 gallons (48,997 gallons total)	Unit 1 Main Transformer/Unit 2 Main Transformer
Muriatic Acid (Hydrochloric Acid)	50 ppm	110 gallons	Units 1 & 2 Water Treatment Area
Nitrogen Gas	Asphyxiant	100,000 cubic feet	Gas House/Trailer

PTN COL 2.2-1

Table 2.2-202 (Sheet 2 of 5)
Onsite Chemical Storage Units 1 through 7

Material	Toxicity Limit IDLH[(a)]	Maximum Quantity in Largest Container	Primary Storage Location
Nitrogen– Liquid	Asphyxiant	3,500 gal	Units 3 & 4 N_2 Dewar Tanks
Number 2 Fuel Oil/Diesel Fuel	None Established	4,300,000 gallon above ground storage tank (4,510,632 total)	Unit 5 Southeast Corner
Number 6 Fuel Oil (Residual Fuel Oil)	None Established	(2) 268,000 barrel (11,256,000 gallon) above ground storage tanks	Fossil Fuel Tank Farm-NE corner of site
Organometallic Magnesium Complex	None Established	134,000 pounds	Units 1 & 2 East Side Chem Feed Area
Oxygen Gas	May displace air and cause an oxygen enriched environment	150 pound cylinders (3,000 pounds total)	Welding Gas House
Propane	2,100 ppm	500 Gallons	Units 1 & 2-NE of Metering Tanks
Silicone	None Established	568 gallons (1,136 gallons total)	Unit 1 Power Potential Transformer/Unit 2 Power Potential Transformer
Sodium Bicarbonate	None Established	50 pound bags (10,000 pounds total)	Unit 1 Boiler Dry Storage Warehouse
Sodium Hydroxide	10 mg/m^3	Fiber drums (1,900 pounds total)	Units 1 & 2 Water Treatment Plant/Units 3 & 4 Central Receiving Warehouse
Sodium Hypochlorite	10 ppm as chlorine	6,000 gallon tank	Unit 5 South of Cooling Tower
Sodium Molybdate	5 mg/m^3 (as Mo)	80 gallons	Unit 3 Condensate Polisher Bldg
Sodium Nitrite	None Established	80 gallons	Unit 3 Condensate Polisher Bldg
Sodium Tetraborate	1 mg/m^3[(b)]	22,000 pounds	Units 3 & 4 Dry Stores
Sulfuric Acid	15 mg/m^3	6,000 gallons (12,500 gallons total)	Units 3 & 4 Water Treatment Plant/ Unit 5 South of Cooling Tower
Sulfuric Acid (Station Batteries)	15 mg/m^3	2,913 pounds	Units 1 & 2 Station Battery Rooms
Trisodium Phosphate-Liquid	None Established	300 gallons	Unit 5- North of Steam Turbine

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Table 2.2-202 (Sheet 3 of 5)
Onsite Chemical Storage Units 1 through 7

Material	Toxicity Limit IDLH[a]	Maximum Quantity in Largest Container	Primary Storage Location
Unleaded Gasoline	300 ppm[b]	2,000 gallon split tank (7,000 gallons total)	Vehicle Refueling Area/Land Utilization Vehicular Fuel Tank
Units 6 & 7			
Anionic polymer	None Established	900 gallons	FPL Reclaimed Water Treatment Facility
Ferric Chloride (47% Solution)	1 mg/m^3[c]	90,250 gallons	FPL Reclaimed Water Treatment Facility
Lime ($Ca(OH)_2$)	5 mg/m^3[c]	23,000 gallons	FPL Reclaimed Water Treatment Facility
Sulfuric Acid (93% Solution)	15 mg/m^3	33,600 gallons	FPL Reclaimed Water Treatment Facility/ Cooling Tower/ Turbine Building
Methanol	6,000 ppm	25,000 gallons	FPL Reclaimed Water Treatment Facility
Sodium Hypochlorite (40% Solution)	10 ppm (as chlorine)	20,000 gallons	FPL Reclaimed Water Treatment Facility/ Cooling Tower/ Turbine Building
Alum (49% Solution)	None Established	30,000 gallons	FPL Reclaimed Water Treatment Facility
Sodium Bisulfite (40% Solution)	5 mg/m^3[c]	15,000 gallons	FPL Reclaimed Water Treatment Facility
Sodium Hydroxide	None Established	15,000 gallons	FPL Reclaimed Water Treatment Facility
Polymer (25% Solution)	None Established	275 gallon tote	FPL Reclaimed Water Treatment Facility
Proprietary Scale Inhibitor[d]-Saltwater (Sodium salt of phosphonomethylate diamine)	None Established	10,000 gallons	Cooling Towers
Proprietary Scale Inhibitor[d]-Saltwater (Calcium phosphate, zinc, iron, manganese)	None Established	12,200 gallons	Cooling Towers
Proprietary Scale Inhibitor[d]-Transition from Saltwater to Reclaimed (Silica based scale inhibitor)	None Established	400 gallon tote	Cooling Towers

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Table 2.2-202 (Sheet 4 of 5)
Onsite Chemical Storage Units 1 through 7

Material	Toxicity Limit IDLH[a]	Maximum Quantity in Largest Container	Primary Storage Location
Proprietary Scale Inhibitor[d]-Reclaimed (High Stress Polymer with PSO)	None Established	12,000 gallons	Cooling Towers
Proprietary Scale Inhibitor[d] (17.9% phosphoric acid)	1,000 mg/m^3	800 gallons	Turbine Building
Proprietary Dispersant[d] (Calcium phosphate, zinc, iron, manganese)	None Established	800 gallons	Turbine Building
Proprietary Scale Inhibitor[d] (30% phosphoric acid)	1,000 mg/m^3	800 gallons	Turbine Building
Sodium Bisulfite (25% solution)	5 mg/m^3[c]	80 gallons	Turbine Building
Proprietary Reverse Osmosis Cleaning Chemical[d] (EDTA Salt, Percarbonate Salt, Phosphonic Acid, Tetrasodium Salt)	None Established	Fiber Drums	Turbine Building
Proprietary Reverse Osmosis Cleaning Chemical[d] (Hydroxyalkanoic acid, Inorganic phosphate, EDTA Salt)	None Established	Fiber Drums	Turbine Building
Hydrazine (35% solution)	50 ppm	800 gallons	Turbine Building
Carbohydrazide	None Established	800 gallons	Turbine Building
Morpholine	1,400 ppm	800 gallons	Turbine Building
No. 2 Diesel Fuel Oil	None Established	60,000 gallons	Diesel Generator Day Tanks/Diesel Generator Building/Annex Building
Liquid Nitrogen	Asphyxiant	1,500 gallons	Plant Gas Storage Area
Nitrogen Gas	Asphyxiant	58 cubic feet	Plant Gas Storage Area
Hydrogen Gas	Asphyxiant	40,000 standard cubic feet (Tube Trailer)	Plant Gas Storage Area
Liquid Carbon Dioxide	40,000 ppm	6 tons	Plant Gas Storage Area
Carbon Dioxide Gas	40,000 ppm	104,800 standard cubic feet	Plant Gas Storage Area

PTN COL 2.2-1

Table 2.2-202 (Sheet 5 of 5)
Onsite Chemical Storage Units 1 through 7

Material	Toxicity Limit IDLH[(a)]	Maximum Quantity in Largest Container	Primary Storage Location
Sodium Molybdate	5 mg/m^3 (as Mo-TLV)	45 gallons	Turbine Building
Ethylene Glycol	None Established	45 gallons	Turbine Building

(a) Immediately dangerous to life and health.
(b) Threshold limit value/time-weighted average (TLV-TWA).
(c) Time-weighted average (TWA)
(d) Main constituents of proprietary treatment chemicals are listed.

Source: References 233, 234, 235, 236, 237, 248, 249, 250, 251, 252, 253, 254, 255, 256, and 257

PTN COL 2.2-1

Table 2.2-203
Offsite Chemical Storage — Homestead Air Reserve Base

Material	Toxicity Limit (IDLH)	Maximum Quantity in Largest Container[(a)] (pounds)
Bromotrifluoromethane (Halon 1301)	40,000 ppm	5,440
Diethylene Glycol Monobutyl Ether	None Established	30,625
Diesel Fuel Oil (High Sulfur)	None Established	158,752
Gasoline	300 ppm[(b)]	137,104
Hydrazine	50 ppm	1,437
Jet Fuel	200 mg/m^3[(b)]	23,251,606
Nitrogen (gas)	Asphyxiant	21,648
Oxygen	May displace air and cause an oxygen enriched environment	36,561
Propane	2,100 ppm	185,865

(a) 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.
(b) Threshold limit value/time-weighted average (TLV-TWA).

Source: References 224, 233, 234, and 235

PTN COL 2.2-1

Table 2.2-204
Units 6 & 7 Pipeline Information Summary

Operator	Product	Pipeline Diameter	Pipeline Age	Operating Pressure	Depth of Burial	Distance Between Isolation Valves
Florida Gas Transmission Company-Turkey Point Lateral	Natural Gas Transmission	24 inches	1968	722 psig	3.5 feet	11.8 miles
Florida Gas Transmission Company-Homestead Lateral	Natural Gas Transmission	6.625 inches	1985	722 psig	3.5 feet	NA[(a)]

(a) Due to the proximity and diameter of the Turkey Point lateral pipeline in comparison to the Homestead lateral pipeline, the Turkey Point lateral pipeline presents a greater hazard, and as such, the Turkey Point lateral pipeline analysis is bounding and no further analysis of the Homestead lateral pipeline is warranted.

Source: Reference 204

PTN COL 2.2-1

Table 2.2-205
Hazardous Chemical Waterway Freight, Intracoastal Waterway, Miami to Key West, Florida

Material	Toxicity Limit (IDLH)	Total Quantity (short tons)
Residual Fuel Oil	None established	611,000

Source: References 206 and 234

PTN COL 2.2-1

Table 2.2-206
Aircraft Operations — Significant Factors

Airport	Number of Operations	Distance from Site	Significance Factor[a]
Turkey Point Heliport	79	0.6 miles	N/A[b]
Homestead Air Reserve Base	36,429	4.76 miles	N/A[b]
Ocean Reef Club Airport[c]	Sporadic	7.41 miles	27,454
Miami International Airport[c]	386,681 (2005 operations) 545,558 (2025 projected)	25.5 miles	651,832

(a) $500d^2$ movements per year for sites within 5 to 10 miles and $1000d^2$ movements per year for sites outside 10 miles.
(b) Consistent with RG 1.206, airports with a plant-to-airport distance less than 5 miles from the site is considered regardless of the projected annual operations.
(c) Because the projected number of operations is less than the calculated significance factor, an evaluation for this airport was not conducted.

Source: References 208, 209, 210, and 241

PTN COL 2.2-1

Table 2.2-207 (Sheet 1 of 3)
Units 1-5 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Acetylene Gas	Asphyxiant	2.5–100 percent	Vapor may explode	51.370 psi at –76˚F	Toxicity Analysis—consider as asphyxiant
					Flammability Analysis
					Explosion Analysis
Ammonium Hydroxide	300 ppm (as ammonia)	15–28%	None listed	854,548 Pa at 293.15˚K	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Argon Gas	Asphyxiant	Not flammable	None listed	1,044.630 Pa @117.32˚K	Toxicity Analysis—consider as asphyxiant
Boric Acid	None Established	Not flammable	None listed	N/A-solid	No further analysis required
Carbon Dioxide	40,000 ppm	Not flammable	None listed	907.299 psi @ 75˚F	Toxicity Analysis and consider as asphyxiant
Chlorine	10 ppm	Not flammable	None listed	74.040 psi @ 50˚F	Toxicity Analysis
Citric Acid	None Established	0.28 kg/m^3 (dust)–2.29 kg/m^3 (dust)	None listed	N/A-solid	No further analysis required-low vapor pressure[a]
Hydrated Lime (Calcium Hydroxide)	5 mg/m^3[b]	Not flammable	Noncombustible Solid in solution	Solid—in a solution	No further analysis required[c]
Hydrazine	50 ppm	4.7–100 percent	Vapor may explode	14.4 mm Hg @ 77˚F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Hydrogen Gas	Asphyxiant	4.0–75 percent	Vapor may explode	1.231 psi @ –434˚F	Toxicity Analysis—consider as asphyxiant
					Flammability Analysis
					Explosion Analysis
Hydrogen Peroxide	75 ppm	Not flammable	None listed	0.200 psi @ 90˚F	Toxicity—screened from further analysis using criteria in RG 1.78—low volume
Lead (In battery)	100 mg/m^3 (as lead)	Not flammable	None listed	N/A-solid	No further analysis required

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Table 2.2-207 (Sheet 2 of 3)
Units 1-5 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Lithium Hydroxide	None Established	Not flammable	None listed	N/A-Solid in solution	No further analysis required
Lube Oil	None Established	Combustible-No flammable limits listed	None listed	0.100 psi @ 100˚F	No further analysis required—low vapor pressure[a]
Magnesium Oxide	750 mg/m^3	Not flammable	None listed	N/A-solid	No further analysis required—low vapor pressure[a]
Mineral Oil	2,500 mg/m^3	Combustible-No flammable limits listed	None listed	<0.5mm Hg @ 68˚F	No further analysis required—low vapor pressure[a]
Muriatic Acid (Hydrochloric Acid)	50 ppm	Not flammable	None listed	5.975 psi@ 90˚F	Toxicity Analysis
Nitrogen Gas	Asphyxiant	Not flammable	None listed	1.931 psi @ –344˚F	Toxicity Analysis—consider as asphyxiant
Nitrogen- Liquid	Asphyxiant	Negligible	None listed	1.931 psi @ –344˚F	Toxicity Analysis—consider as asphyxiant
Number 2 Fuel Oil/Diesel Fuel	None Established	1.3–6.0 percent	None listed	0.100 psi @ 100˚F	No further analysis required—low vapor pressure[a]
Number 6 Fuel Oil (Residual Fuel Oil)	None Established	1–5 percent	None listed	0.100 psi @ 100˚F	No further analysis required—low vapor pressure[a]
Organometallic Magnesium Complex	None Established	Not flammable	None listed	N/A-solid	No further analysis required
Oxygen	May displace air and cause an oxygen-enriched environment	Not flammable	None listed	363, 385 Pa at 104.47˚K	Toxicity Analysis—consider for oxygen-enriched environment
Propane	2,100 ppm	2.1–9.5 percent	Vapor may explode	837,489 Pa at 293.15˚K	Toxicity Analysis Flammability Analysis Explosion Analysis/BLEVE
Silicone	None Established	Not flammable	None listed	Not available	No further analysis required
Sodium Bicarbonate	None Established	Not flammable	None listed	N/A-solid	No further analysis required
Sodium Hydroxide	No established IDLH for solution	Not flammable	Noncombustible Solid in solution	Solid—in solution	No further analysis required—low vapor pressure[d]

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Table 2.2-207 (Sheet 3 of 3)
Units 1-5 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Sodium Hypochlorite	10 ppm as chlorine	Not flammable	None listed	31.1 mmHg @ 89.6˚F (12.5% weight percent)	Toxicity Analysis[(e)]
Sodium Molybdate	5 mg/m^3 (as Mo)[(b)]	Not flammable	None listed	N/A-solid	No further analysis required[(f)]
Sodium Nitrite	None Established	Not flammable	None listed	1.818 psi @ 100˚F	No further analysis required
Sodium Tetraborate	1 mg/m^3[(b)]	Not flammable	None listed	N/A-solid	No further analysis required[(a)]
Sulfuric Acid	15 mg/m^3	Not flammable	None listed	0.001 mmHg @ 68˚F	No further analysis required—low vapor pressure[(a)]
Sulfuric Acid (Station Batteries)	15 mg/m^3	Not flammable	None listed	0.001 mmHg @ 68˚F	No further analysis required—low vapor pressure[(a)]
Trisodium Phosphate-Liquid	None Established	Not flammable	None listed	Not available	No further analysis required
Unleaded Gasoline[(g)]	300 ppm[(b)]	1.4–7.4 percent	Vapor may explode	4,703.3 Pa @ 293.15˚K	No further analysis required[(g)]

(a) Solids and 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.
(b) Threshold limit value/ time-weighted average (TLV-TWA).
(c) Lime (calcium hydroxide) is listed as a noncombustible solid and with a very low—approximate vapor pressure of 0 mmHg. The toxicity data provided by NIOSH provides the following basis for the standard established by OSHA for general industry: "8 hour time-weighted average 15 mg/m^3, total dust" and "5 mg/m^3, respirable fraction." Thus, this toxicity limit was established for the exposure to the solid form. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(d) Sodium hydroxide in its pure form is a noncombustible solid and therefore has a very low vapor pressure. The IDLH documentation provided by NIOSH provides the following description of the substance—"colorless to white, odorless solid (flakes, beads, granular form)" and provides the following basis for establishing the 10 mg/m^3 IDLH limit for the solid form—"the revised IDLH for sodium hydroxide is 10-mg/m^3 based on acute inhalation toxicity data for workers [Ott et al. 1977]" where the reference for Ott et. al gives the following description "Mortality among employees chronically exposed to caustic dust". Thus, this toxicity limit was established for the exposure to the solid form is not applicable to the solution. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(e) Sodium hypochlorite does not have a determined IDLH value listed in NIOSH; however, MSDS have listed a toxicity limit for sodium hypochlorite as 10 ppm—as chlorine. Speculation exists on the exact chlorine species that are present in the vapor. The vapor pressures of sodium hypochlorite solutions are less than the vapor pressure of water at the same temperature. However, because of the potential for sodium hypochlorite to decompose and release chlorine gas upon heating, sodium hypochlorite was conservatively evaluated for toxicity.
(f) Sodium molybdate is a noncombustible solid and therefore has a very low vapor pressure. There is no IDLH or other toxicity limits for sodium molybdate. There are, however, IDLH, PEL and TLVs for Molybdenum. These exposure limits are based upon dusts, inhalable and respirable fractions. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(g) Onsite Gasoline is bounded by Onsite Transport of Gasoline.

Source: References 217, 233, 234, 235, 236, 237, and 238

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Table 2.2-208 (Sheet 1 of 4)
Units 6 & 7 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
FPL Reclaimed Water Treatment Facility					
Anionic polymer	None Established	Not Flammable	None Listed	Solution	No further analysis required—skin/eye irritant only.
Ferric Chloride (47% Solution)	1 mg/m^3 [(a)]	Not Flammable	Noncombustible solid	Solid—in a solution	No further analysis required—TWA established for solid salts—not applicable to solution.[(b)]
Lime ($Ca(OH)_2$)	5 mg/m^3 [(a)]	Not Flammable	Noncombustible solid in solution	Solid—in a solution	No further analysis required.[(c)]
Sulfuric Acid (93% Solution)	15 mg/m^3	Not Flammable	None Listed	0.001 mm Hg @ 68°F	No further analysis required.[(d)]
Methanol (Denitrification)	6,000 ppm	6–36 percent	Vapor may explode	96 mmHg @ 68°F	Toxicity Analysis Flammability Analysis Explosion Analysis
Sodium Hypochlorite (40% Solution) Disinfection	10 ppm as Cl_2	Not Flammable	None Listed	31.1 mmHg @ 89.6°F (12.5% Weight Percent)	Toxicity Analysis [(e)]
Alum (49% Solution) (Phosphorus Removal)	None established	Not Flammable	None Listed	Solid—in a solution	No further analysis required.
Sodium Bisulfite (40% Solution) (Dechlorination)	5 mg/m^3 [(a)]	Not Flammable	None Listed	Solid—in a solution	No further analysis required. TWA established for solid—not applicable to solution.[(f)]
Sodium Hydroxide (50% Solution)	10 mg/m^3	Not Flammable	Noncombustible solid in solution	Solid—in a solution	No further analysis required. TWA established for solid—not applicable to solution. [(g)]
Polymer (25% Solution)	None established	Not Flammable	None Listed	Solution	No further analysis required—skin/eye irritant only.
Circulating Water System					
Sodium Hypochlorite—(12 Trade Percent)	10 ppm as Chlorine	Not Flammable	None Listed	31.1 mmHg @ 89.6°F (12.5% Weight Percent)	Toxicity Analysis [(e)]
Sulfuric Acid (93% Solution)—Saltwater	15 mg/m^3	Not Flammable	None Listed	0.001 mm Hg	No further analysis required.[(d)]
Proprietary Scale Inhibitor—Saltwater (Sodium salt of phosphonomethylate diamine)	Does not contain any substance that has an exposure limit	Not Flammable	None Listed	Inhalation not a likely route of exposure	No further analysis required.

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Table 2.2-208 (Sheet 2 of 4)
Units 6 & 7 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Circulating Water System (cont.)					
Proprietary Scale Inhibitor—Saltwater (Calcium phosphate, zinc, iron, manganese)	None Established	Not Flammable	None Listed	Inhalation not a likely route of exposure	No further analysis required.
Proprietary Scale Inhibitor—Transition from Saltwater to Reclaimed (Silica based scale inhibitor)	None Established	Not expected to burn unless all water is boiled away—remaining organics may be ignitable	None Listed	Solution	No further analysis required.
Proprietary Scale Inhibitor—Reclaimed (High Stress Polymer with PSO)	Does not contain any substance that has an exposure limit	Not Flammable	None Listed	16 mmHg @ 100°F	No further analysis required.
Service Water System					
Sulfuric Acid (93% Solution) (pH Addition)	15 mg/m^3	Not Flammable	None Listed	0.001 mm Hg	No further analysis required.[(d)]
Proprietary Scale Inhibitor (17.9% Phosphoric Acid)	1,000 mg/m^3	Not Flammable	None Listed	water/phosphoric acid=0.03mmHg	No further analysis required.[(h)]
Proprietary Dispersant (Calcium phosphate, zinc, iron, manganese)	None Established	Not Flammable	None Listed	Inhalation not a likely route of exposure	No further analysis required.
Sodium Hypochlorite (12 Trade Percent)	10 ppm as Cl_2	Not Flammable	None Listed	31.1 mmHg @ 89.6°F (12.5% Weight Percent)	Toxicity Analysis [(e)]
Demineralized Water System					
Proprietary Scale Inhibitor—(30% Phosphoric Acid)	1,000 mg/m^3	Not Flammable	None Listed	water/phosphoric acid=0.03mmHg	No further analysis required.[(h)]
Sodium Bisulfite (25% Solution)	5 mg/m^3 [(a)]	Not Flammable	None Listed	Solid—in a solution	No further analysis required. TWA established for solid—not applicable to solution.[(f)]
Sulfuric Acid (93% Solution)	15 mg/m^3	Not Flammable	None Listed	0.001 mm Hg	No further analysis required.[(d)]
Reverse Osmosis (RO) Cleaning Chemicals					
Proprietary Reverse Osmosis Cleaning Chemical (EDTA Salt, Percarbonate Salt, Phosphonic Acid, Tetrasodium Salt)	None established	Not Flammable	None Listed	Solid—in a solution	No further analysis required.

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Table 2.2-208 (Sheet 3 of 4)
Units 6 & 7 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Reverse Osmosis (RO) Cleaning Chemicals (cont.)					
Proprietary Reverse Osmosis Cleaning Chemical (Hydroxyalkanoic acid, Inorganic phosphate, EDTA Salt)	None established	Not Flammable	None Listed	Solid—in a solution	No further analysis required.
Steam Generator Blowdown System					
Hydrazine-oxygen scavenger (35% solution)	50 ppm	4.7–100 percent	Vapor may explode	14 mmHg @ 77°F	Toxicity Analysis Flammability Analysis Explosion Analysis
Carbohydrazide—oxygen scavenger (Shut Down)	None established	Not flammable-unless water is boiled away and chemical is heated	None Listed	12 mm Hg @ 20°C	No further analysis required.
Morpholine	1,400 ppm[(i)]	1.4–11.2 percent	Vapor may explode	6 mmHg @ 68°F	Toxicity Analysis Flammability Analysis Explosion Analysis
Standby Diesel Fuel Oil System					
No. 2 Diesel Fuel Oil-Diesel Generator Day Tank	None Established	1.3–6.0 percent	None Listed	0.100 psi @ 100°F	No further analysis required—low vapor pressure.[(k)]
No. 2 Diesel Fuel Oil-Ancillary Diesel Generator	None Established	1.3–6.0 percent	None Listed	0.100 psi @ 100°F	No further analysis required—low vapor pressure.[(k)]
No. 2 Diesel Fuel Oil-Diesel Fire Pump Day Tank	None Established	1.3–6.0 percent	None Listed	0.100 psi @ 100°F	No further analysis required—low vapor pressure.[(k)]
Fire Protection System					
No. 2 Diesel Fuel Oil	None Established	1.3–6.0 percent	None Listed	0.100 psi @ 100°F	No further analysis required—low vapor pressure.[(k)]
Plant Gas System					
Nitrogen-Liquid	Asphyxiant	Negligible	None Listed	1.931 psi @ -344°F	Toxicity Analysis—consider as asphyxiant
Nitrogen Gas	Asphyxiant	Not Flammable	None Listed	1.931 psi @ -344F°	Toxicity Analysis—consider as asphyxiant
Hydrogen Gas	Asphyxiant	4.0–75 percent	Vapor may explode	1.231 psi @ -434°F	Toxicity Analysis—consider as asphyxiant Flammability Analysis Explosion Analysis

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Table 2.2-208 (Sheet 4 of 4)
Units 6 & 7 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Plant Gas System (cont.)					
Carbon Dioxide-Liquid	40,000 ppm	Not Flammable	None Listed	907.299 psi @ 75°F	Toxicity Analysis—consider as asphyxiant
Carbon Dioxide Gas	40,000 ppm	Not Flammable	None Listed	907.299 psi @ 75°F	Toxicity Analysis—consider as asphyxiant
Central Chilled Water System					
Sodium Molybdate (Corrosion Inhibitor)	5 mg/m^3 (as Mo) (l)	Not Flammable	None Listed	Solid in a solution	No further analysis required (m)
Ethylene Glycol	None Established	3.2–15.3 percent	Vapor may explode	0.003 psi @ 90°F	No further analysis required—low vapor pressure.(n)

(a) Time Weighted Average (TWA)
(b) Ferric chloride in its pure form is a noncombustible solid and therefore has a very low vapor pressure. The IDLH documentation provided by NIOSH provides the following basis for establishing the 1 mg/m^3 TWA limit—"The ACGIH…considers the salts to be irritants to the respiratory tract when inhaled as dusts and mists." Thus, this toxicity limit was established for the exposure to the solid form. Note, there is no IDLH established for this chemical. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(c) Lime (calcium hydroxide) is listed as a noncombustible solid and with a very low– approximate vapor pressure of 0 mmHg. The toxicity data provided by NIOSH provides the following basis for the standard established by OSHA for general industry: "8 hour time-weighted average 15 mg/m^3, total dust" and "5 mg/m^3, respirable fraction." Thus, this toxicity limit was established for the exposure to the solid form. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(d) Sulfuric acid has a very low vapor pressure and therefore an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(e) Sodium hypochlorite does not have a determined IDLH value listed in NIOSH; however, MSDS have listed a toxicity limit for sodium hypochlorite as 10 ppm—as chlorine. Speculation exists on the exact chlorine species that are present in the vapor. The vapor pressures of sodium hypochlorite solutions are less than the vapor pressure of water at the same temperature. However, because of the potential for sodium hypochlorite to decompose and release chlorine gas upon heating, sodium hypochlorite was conservatively evaluated for toxicity.
(f) Sodium bisulfite in its pure form is a noncombustible solid and therefore has a very low vapor pressure. The IDLH documentation provided by NIOSH provides the following basis for establishing the 5 mg/m^3 TWA limit—"the 5-mg/m^3 limit was proposed because it represents a limit below that established for physical irritant particulates, and this limit reflects the irritant properties of sodium bisulfite. And, in the judgement of the ACGIH "inhalation of or contact with the dust would result in high local concentrations [of sodium bisulfite] in contact with high local concentrations of sensitive tissue. Thus, this toxicity limit was established for the exposure to the solid form is not applicable to the solution. Note, there is no IDLH established for this chemical. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(g) Sodium hydroxide in its pure form is a noncombustible solid and therefore has a very low vapor pressure. The IDLH documentation provided by NIOSH provides the following description of the substance—"colorless to white, odorless solid (flakes, beads, granular form)" and provides the following basis for establishing the 10 mg/m^3 IDLH limit for the solid form—"the revised IDLH for sodium hydroxide is 10-mg/m^3 based on acute inhalation toxicity data for workers [Ott et al. 1977]" where the reference for Ott et. al gives the following description "Mortality among employees chronically exposed to caustic dust". Thus, this toxicity limit was established for the exposure to the solid form is not applicable to the solution. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(h) Phosphoric acid in its pure form is a noncombustible solid and therefore has a very low vapor pressure. The IDLH documentation provided by NIOSH provides the following basis for the original IDLH of 10,000 mg/m^3—according to the Manufacturing Chemists Association, phosphoric acid does not cause any systemic effect and the chance of pulmonary edema from mist or spray inhalation is very remote. And, the basis for the revised IDLH for phosphoric acid, 1,000 mg/m^3, is based on acute oral toxicity data in animals. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(i) The IDLH documentation provided by NIOSH states that based on health considerations and acute inhalation toxicity data in humans and animals, a value of 2000 ppm would have been appropriate for morpholine. However, the revised IDLH for morpholine is 1400 ppm based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 1.4%)
(j) Not used.
(k) Diesel Fuel has a low vapor pressure and therefore an air dispersion hazard resulting from the formation of a flammable vapor cloud is not a likely route of exposure.
(l) Threshold Limit Value (TLV)
(m) Sodium molybdate is a noncombustible solid and therefore has a very low vapor pressure. There is no IDLH or other toxicity limits for sodium molybdate. There are, however, IDLH, PEL and TLVs for molybdenum. These exposure limits are based upon dusts, inhalable and respirable fractions. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(n) Ethylene glycol has a low vapor pressure and therefore an air dispersion hazard resulting from the formation of a flammable vapor cloud is not a likely route of exposure.
Source: References 217, 233, 234, 235, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, and 257

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Table 2.2-209
Offsite Chemicals, Disposition — Homestead Air Reserve Base

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Bromotrifluoromethane (Halon 1301)	40,000 ppm	Not flammable	None listed	1,436,150 Pa at 293.15˚K	Toxicity Analysis
Diesel Fuel Oil (High Sulfur)	None Established	1.3–6.0 percent	None listed	0.100 @ 100˚F	No further analysis required-low vapor pressure[a]
Diethylene Glycol Monobutyl Ether	None Established	Not flammable	None listed	0.159 @ 220˚F	No further analysis required
Gasoline	300 ppm[b]	1.4–7.4 percent	Vapor may explode	4,703.3 Pa @ 293.15˚K	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Hydrazine[c]	50 ppm	4.7–100 percent	Vapor may explode	14.4 mm Hg @ 77˚F	No further analysis required[c]
Jet Fuel	200 mg/m^3[b]	0.6–4.9 percent	Vapor may explode	0.1 psi @ 100˚F	Explosion Analysis—no flammability/toxicity analysis required low vapor pressure[a]
Nitrogen Gas[c]	Asphyxiant	Not flammable	None listed	1.93 psi @ –344˚F	No further analysis required[c]
Oxygen	May displace air and cause an oxygen enriched environment	Not flammable	None listed	363,385 Pa at 104.47˚K	Toxicity Analysis-consider for oxygen enriched environment
Propane	2,100 ppm	2.1–9.5 percent	Vapor may explode	837,489 Pa at 293.15˚K	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis

(a) Solids and 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.
(b) Threshold limit value/ time-weighted average (TLV-TWA).
(c) Homestead Air Reserve Base storage of hydrazine and nitrogen is bounded by Turkey Point onsite storage of hydrazine and nitrogen.
Source: References 217, 233, 234, and 235

PTN COL 2.2-1

Table 2.2-210
Transportation — Navigable Waterway, Turkey Point Lateral Pipeline, and Onsite Transportation Route — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Navigable Waterway					
Residual Fuel Oil	None established	1–5 percent	None listed	0.100 psi @ 100°F	No further analysis required—hazard analysis bounded by residual fuel storage at Units 1–5 [(a) (c)]
Turkey Point Lateral Pipeline					
Natural Gas (methane)	Asphyxiant	5–15 percent	Vapor may explode	258,574.0 mm Hg @ 100°F	Toxicity Analysis-consider as asphyxiant
					Flammability Analysis
					Explosion Analysis
Onsite Transportation Route					
Unleaded Gasoline	300 ppm[(b)]	1.4–7.4 percent	Vapor may explode	4,703.3 Pa @ 293.15°K	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis

(a) Solids and 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.
(b) Threshold limit value/ time-weighted average (TLV-TWA).
(c) As described in Subsection 2.2.2.4, because of the storage of residual fuel oil at the Turkey Point site, (2) 268,000 barrel tanks exceeds the quantity transported by a barge, the analysis of residual fuel oil located in the storage tanks is bounding and, therefore, no further analysis is required.

Source: References 217, 233, 234, and 235

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Table 2.2-211
Atmospheric Input data for the ALOHA Model

Menu	Parameter	Input	Basis
Site Atmospheric Data			
Site Data	Number of Air Exchanges	0.74 air exchanges per hour	Outdoor air exchange rate for control room.
Site Data	Date and Time	June 21, 2007/ June 20, 2008 See Table 2.2-212 for Times	June 21, 2007/June 20, 2008 at 12 noon was chosen because temperatures are highest in the summer during midday. Higher temperatures lead to a higher evaporation rate and thus a larger vapor cloud. The position of the sun for the date and time is used in determining the solar radiation, thus the summer solstice date will provide the most conservative assumption for solar radiation. June 21, 2007/June 20, 2008 at 5 am was chosen for those Pasquill classes defined as “nighttime.”
Setup/Atmospheric	Wind Measurement Height	10 meters	ALOHA calculates a wind profile based on where the meteorological data is taken. ALOHA assumes that the meteorological station is at 10 meters. The National Weather Service usually reports wind speeds from a height of 10 meters. Wind rose data for this project was also taken at a height of 10 meters. Additionally, the surface wind speeds for determining the Pasquill Stability Class are defined at 10m.
Setup/Atmospheric	Air Temperature	90.4ºF	Air temperature influences ALOHA’s estimate of the evaporation rate from a puddle surface (the higher the air temperature, the more the puddle is warmed by the air above it, the higher the liquid’s vapor pressure is, and the faster the substance evaporates).
Setup/Atmospheric	Inversion Height	None	An inversion is an atmospheric condition that serves to trap the gas below the inversion height thereby not allowing it to disperse normally. Inversion height has no affect on the heavy gas model. And, most inversions are at heights much greater than ground level.
Setup/Atmospheric	Humidity	50%	ALOHA uses the relative humidity values to estimate the atmospheric transmissivity value; estimate the rate of evaporation from a puddle; and make heavy gas dispersion computations. Atmospheric transmissivity is a measure of how much thermal radiation from a fire is absorbed and scattered by the water vapor and other atmospheric components.

Source: References 217 and 240

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Table 2.2-212
ALOHA Meteorological Sensitivity Analysis Inputs

Stability Class	Surface Wind Speed (m/s)	Cloud Cover	Date/Time
A	1.5	0%	June 21, 2007/12 noon or June 20, 2008/12 noon
B	1.5	50%	June 21, 2007/12 noon or June 20, 2008/12 noon
B	2	0%	June 21, 2007/12 noon or June 20, 2008/12 noon
C	3	70%	June 21, 2007/12 noon or June 20, 2008/12 noon
E	2	50%	June 21, 2007/5 am or June 20, 2008/5 am
F	1	0%	June 21, 2007/5 am or June 20, 2008/5 am
F	2	0%	June 21, 2007/5 am or June 20, 2008/5 am
F	3 (only modeled for vapor clouds taking greater than 1 hour to reach the control room)	0%	June 21, 2007/5 am or June 20, 2008/5 am
C	3	50%	June 21, 2007/12 noon or June 20, 2008/12 noon
D	3	50%	June 21, 2007/5 am or June 20, 2008/5 am
C	5.5	0%	June 21, 2007/12 noon or June 20, 2008/12 noon
D	5.5	50%	June 21, 2007/12 noon or June 20, 2008/12 noon

Source: References 217 and 239

PTN COL 2.2-1

Table 2.2-213
Design Basis Events — Explosions

Source	Chemical Evaluated	Quantity	Heat of Combustion (Btu/lb)	Distance to Nearest Safety-Related Structure	Safe Distance for Explosion to have less than 1 psi of Peak Incident Pressure	Thermal Radiation Heat Flux Resulting from a BLEVE
Road: Onsite Transport	Gasoline	50,000 pounds	18,720 Btu/lb	2,054 feet	266 feet	N/A
Pipeline: Turkey Point Lateral	Natural Gas	30,302 pounds[(b)]	21,517 Btu/lb	4,535 feet	3,097 feet	N/A
Onsite (Includes Units 1 thru through 5)	Acetylene	3,000 pounds	20,747 Btu/lb	4,300 feet	1,416 feet	N/A
	Ammonium Hydroxide	40,000 gallons	7,992 Btu/lb	5,079 feet	296 feet	N/A
	Hydrazine	1,100 gallons	8,345 Btu/lb	2,727 feet	170 feet	N/A
	Hydrogen	110,000 cubic feet[(c)]	50,080 Btu/lb	3,966 feet	1,098 feet	N/A
	Propane	500 gallons	19,782 Btu/lb	4,168 feet	1,299 feet	0.0878 kW/m^2
Onsite (Includes Units 6 & 7)	Methanol	25,000 gallons	8,419 Btu/lb	5,581 feet	344 feet	N/A
	Hydrazine (35% solution)	800 gallons	8,345 Btu/lb	218 feet	153 feet	N/A
	Morpholine	800 gallons	20,000 Btu/lb	218 feet	136 feet	N/A
	Hydrogen[(a)]	13,334 standard cubic feet	50,080 Btu/lb	560 feet	544 feet	N/A
Offsite (Homestead Air Reserve Base)	Gasoline	137,104 pounds	18,720 Btu/lb	25,133 feet	372 feet	N/A
	Jet Fuel	23,251,606 pounds	18,540 Btu/lb		2,232 feet	N/A
	Propane	185,865 pounds	19,782 Btu/lb		5,513 feet	N/A

(a) A simultaneous detonation of all the tubes contained in a 40,000 scf hydrogen tube bank is not a likely scenario. If a rupture and subsequent detonation of a single tube were to occur the event could likely trigger another tube failure and detonation, but these events would occur consecutively, not simultaneously. Therefore, detonation of mass from a single tube in hydrogen bank is the most plausible scenario; however, for conservatism, it was assumed that a catastrophic accident could result such that one-third of the tubes could rupture and detonate simultaneously.
(b) Quantity of natural gas released over 5 seconds after a postulated pipeline rupture.
(c) Conservatively, the total hydrogen gas capacity for Units 1–5 was evaluated in lieu of the volume of the largest container.

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Table 2.2-214
Design-Basis Events, Flammable Vapor Clouds (Delayed Ignition) and Vapor Cloud Explosions

Source	Chemical Evaluated & Quantity	Distance to Nearest Safety-Related Structure	Distance to LFL	Safe Distance for Vapor Cloud Explosions	Thermal Radiation Heat Flux at Nearest Safety-Related Structure
Road: Onsite Transport	Gasoline (50,000 pounds)	2,054 feet	402 feet[e]	1,014 feet[e]	2.776 kW/m2
Pipeline: Turkey Point Lateral	Natural Gas	4,535 feet	750 feet[a]	3,033 feet[a]	0.261 kW/m2 [b]
Onsite (Includes Units 1 through 5)	Acetylene (3,000 pounds)	4,300 feet	1,308 feet[e]	1,764 feet[e]	0.162 kW/m2
	Ammonium Hydroxide (40,000 gal)	5,079 feet	354 feet[c][a][h]	963 feet [c][a][h]	0.900 kW/m2
	Hydrazine (1,100 gal)	2,727 feet	42 feet[a]	No Detonation[d]	0.271 kW/m2
	Hydrogen (45,000 scf)	3,966 feet	1,032 feet[e]	1,182 feet[e]	0.033 kW/m2
	Propane (500 gal)	4,168 feet	738 feet[f]	1,416 feet[a]	0.090 kW/m2
Onsite (Includes Units 6 & 7)	Hydrazine (800 gal) (35% solution)	218 feet	< 33 feet[c][i]	No Detonation [c][d][i]	N/A
	Hydrogen Tube Bank (40,000 scf)	560 feet	507 feet[c][e]	432 feet[c][e][g]	2.344 kW/m2
	Methanol (25,000 gal)	5,581 feet	282 feet[e]	804 feet[e]	0.592 kW/m2
	Morpholine (800 gal)	218 feet	< 33 feet[a][i]	No Detonation [c][d][i]	N/A
Offsite (Homestead Air Force Base)	Gasoline (137,104 lb)	25,133 feet	678 feet[e]	1,623 feet[e]	0.051 kW/m2
	Propane (185,865 lb)		2,190 feet[a]	4,866 feet[e]	0.078 kW/m2

(a) Worst-case scenario meteorological condition was F stability class at two meters per second
(b) Thermal radiation heat flux resulting from a jet fire at the pipeline break.
(c) Urban or Forest ground roughness selected
(d) "No detonation" is listed when ALOHA reports that there is no detonation of the formed vapor cloud-that is no part of the cloud is above the LEL at any time.
(e) Worst-case scenario meteorological condition was F stability class at one meters per second
(f) Worst-case scenario meteorological condition was F stability class at one meters per second at 78°F
(g) For the vapor cloud explosion analysis, the amount of hydrogen released is assumed to be 13,334 scf. It is assumed that a catastrophic accident could result such that one third of the tubes rupture and release their entire contents, which travel towards the nearest safety-related structure prior to detonation.
(h) 40,000 gallons of ammonium hydroxide were released within an area of 44,415 ft^2. This is conservative because the analyzed puddle expands greater than the dike area surrounding the ammonium hydroxide tanks. The analyzed puddle expands to nearby drains.
(i) Hydrazine and morpholine were released within a diked area of 768 ft^2 for the Units 6 & 7 onsite chemical analysis.

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Table 2.2-215 (Sheet 1 of 2)
Design-Basis Events, Toxic Vapor Clouds

Source	Chemical	Quantity	IDLH[a]	Distance to Nearest Control Room (feet)	Distance to IDLH (feet)	Maximum Control Room Concentration (ppm)
Road: Onsite Transport	Gasoline	50,000 pounds	300 ppm(b)	2,084	1,962	115[d]
Pipeline: Turkey Point Lateral	Natural Gas	2,036,620 pounds	Asphyxiant	4,535	N/A	855[d]
Onsite (Includes Units 1 through 5)	Acetylene	3,000 pounds	Asphyxiant	4,331	N/A	157[g]
	Ammonium Hydroxide(c)	40,000 gallons	300 ppm	5,110	10,560[i]	253[d][c][i]
	Argon	3,000 pounds	Asphyxiant	4,001	N/A	29.9[g]
	Carbon Dioxide	9,000 pounds	40,000 ppm	4,001	963	321[g]
	Chlorine	150 pounds	10 ppm	2,994	3,474	1.68[g]
	Hydrazine	1,100 gallons	50 ppm	2,758	2,178	14.1[d]
	Hydrogen	45,000 scf	Asphyxiant	4,001	N/A	185[g]
	Muriatic Acid	110 gallons	50 ppm	4,429	1,983	2.13[g]
	Nitrogen Gas	100,000 scf	Asphyxiant	3,596	N/A	500[g]
	Nitrogen Liquid	3,500 gallons	Asphyxiant	3,596	N/A	340[g]
	Oxygen	3,000 pounds	May displace air and cause an oxygen enriched environment	4,329	N/A	34.8[g]
	Propane	500 gallons	2100 ppm	4,198	1,878	26.2[g]
	Sodium Hypochlorite	6,000 gallons	10 ppm as Chlorine	5,232	1,752	0.327[d][c]

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Table 2.2-215 (Sheet 2 of 2)
Design-Basis Events, Toxic Vapor Clouds

Source	Chemical	Quantity	IDLH[a]	Distance to Nearest Control Room (feet)	Distance to IDLH (feet)	Maximum Control Room Concentration (ppm)
Onsite (Includes Units 6 & 7)	Carbon Dioxide	12,160 pounds	40,000 ppm	561 feet	591 feet	4,980 ppm[c][g]
	Carbon Dioxide-Liquid	12,000 pounds	40,000 ppm	561 feet	969 feet	5,130 ppm[c][g]
	Hydrazine (35% solution)	800 gallons	50 ppm	253 feet	336 feet	40.7 ppm[c][g][j]
	Hydrogen Tube Bank	40,000 standard cubic feet	Asphyxiant	561 feet	N/A	1,890 ppm[c][g]
	Methanol	25,000 gallons	6,000 ppm	5,660 feet	1,131 feet	128 ppm[d]
	Morpholine	800 gallons	1,400 ppm	253 feet	39 feet	9.96 ppm[c][g]
	Nitrogen	20,34.2 pounds	Asphyxiant	561 feet	N/A	1,310 ppm[c][g]
	Nitrogen-Liquid	1,500 gallons	Asphyxiant	561 feet	N/A	2,160 ppm[c][h]
	Sodium Hypochlorite (Reclaimed Water Treatment Facility)	20,000 gallons	10 ppm as Chlorine	5,660 feet	6,864 feet	2.68 ppm[d]
	Sodium Hypochlorite (Cooling Tower)	12,000 gallons	10 ppm as Chlorine	807 feet	2,622 feet	5.59 ppm[d]
	Sodium Hypochlorite (Turbine Building)	800 gallons	10 ppm as Chlorine	253 feet	120 feet	1.15 ppm[c][g]
Offsite (Homestead Air Reserve Base)	Halon 1301	5,440 pounds	40,000 ppm	25,133 feet	99 feet	0.273 ppm[e]
	Gasoline	137,104 pounds	300 ppm(b)		2,199 feet	1.91 ppm[f]
	Oxygen	36,561 pounds	May displace air and cause an oxygen enriched environment		N/A	9.39 ppm[e]
	Propane	185,865 pounds	2,100 ppm		6,864 feet	19.6 ppm[e]

(a) Immediately Dangerous to Life or Health (IDLH)
(b) Threshold Limit Value/ Time-Weighted Average (TLV-TWA)
(c) Calculation was modeling selecting the Urban or Forest for Ground Roughness
(d) Worst-case scenario meteorological condition was F stability class at two meters per second
(e) Worst-case scenario meteorological condition was F stability class at three meters per second
(f) Worst-case scenario meteorological condition was D stability class at 5.5 meters per second
(g) Worst-case scenario meteorological condition was F stability class at one meters per second
(h) Worst-case scenario meteorological condition was F stability class at one meters per second at 78°F
(i) 40,000 gallons of ammonium hydroxide were released within an area of 44,415 ft^2. This is conservative because the analyzed puddle expands greater than the dike area surrounding the ammonium hydroxide tanks. The analyzed puddle expands to nearby drains.
(j) Hydrazine and morpholine were released within a diked area of 768 ft^2 for the Units 6 & 7 onsite chemical analysis.

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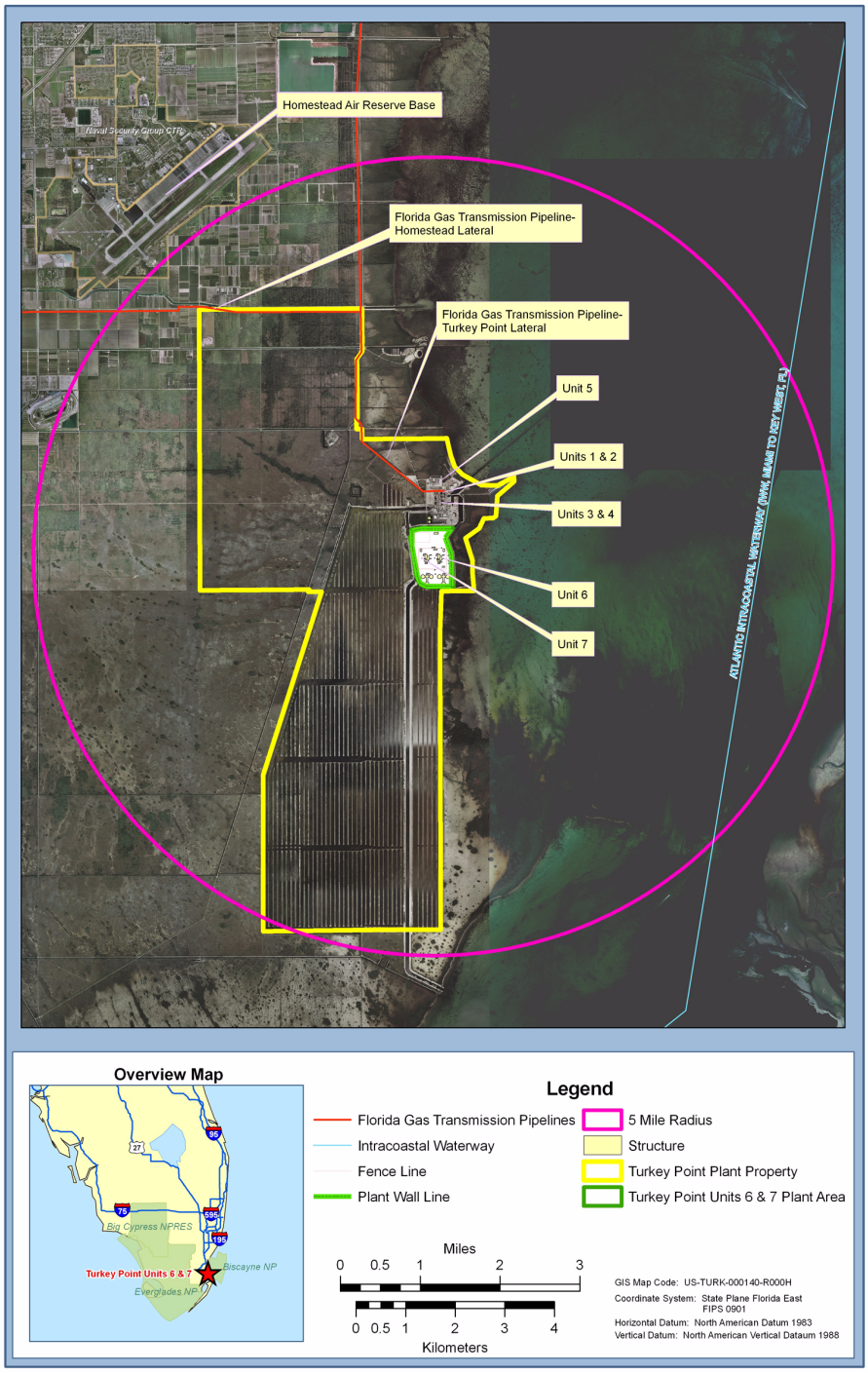
Figure 2.2-201 Site Vicinity Map



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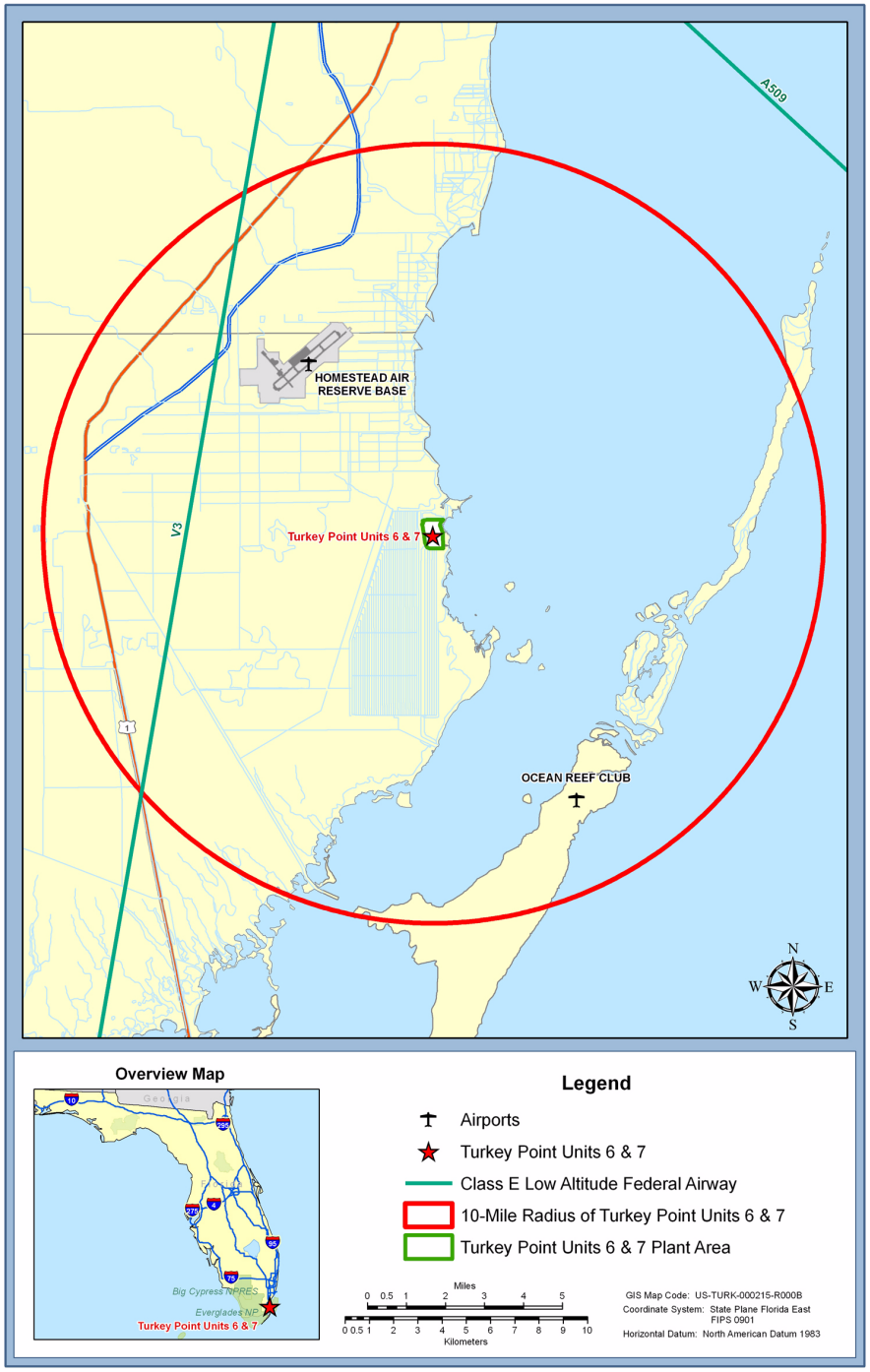
Figure 2.2-202 Airport and Airway Map