Group A

FOIA/PA NO: 2015-0204

RECORDS BEING RELEASED IN PART

The following types of information are being withheld:

Ex. 1: ☐ Records properly classified pursuant to Executive Order 13526
Ex. 2: ☐ Records regarding personnel rules and/or human capital administration
Ex. 3: ☐ Information about the design, manufacture, or utilization of nuclear weapons
☐ Information about the protection or security of reactors and nuclear materials
☐ Contractor proposals not incorporated into a final contract with the NRC
☐ Other ______________________________
Ex. 4: ☑ Proprietary information provided by a submitter to the NRC
☐ Other ______________________________
Ex. 5: ☐ Draft documents or other pre-decisional deliberative documents (D.P. Privilege)
☐ Records prepared by counsel in anticipation of litigation (A.W.P. Privilege)
☐ Privileged communications between counsel and a client (A.C. Privilege)
☐ Other ______________________________
Ex. 6: ☐ Agency employee PII, including SSN, contact information, birthdates, etc.
☐ Third party PII, including names, phone numbers, or other personal information
Ex. 7(A): ☐ Copies of ongoing investigation case files, exhibits, notes, ROI's, etc.
☐ Records that reference or are related to a separate ongoing investigation(s)
Ex. 7(C): ☐ Special Agent or other law enforcement PII
☐ PII of third parties referenced in records compiled for law enforcement purposes
Ex. 7(D): ☐ Witnesses' and Allegers' PII in law enforcement records
☐ Confidential Informant or law enforcement information provided by other entity
Ex. 7(E): ☐ Law Enforcement Technique/Procedure used for criminal investigations
☐ Technique or procedure used for security or prevention of criminal activity
Ex. 7(F): ☐ Information that could aid a terrorist or compromise security

Other/Comments: ______________________________

2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

2.2.1 LOCATIONS AND ROUTES

The major transportation routes located within 5 miles of the site include the following:

a. U.S. Route 422, an east-west highway passing approximately 1½ miles north of the site;

b. Pennsylvania Route 100, a north-south highway passing approximately 4 miles west of the site;

c. Pennsylvania Route 724, a southeast-northwest highway passing approximately 1 mile southwest of the site;

d. The Consolidated Rail Corporation (ConRail) line (formerly Reading Company) passing through the site along the east bank of the Schuylkill River. The line is comprised of two tracks, and has a rail spur serving the station; and

e. The ConRail line (formerly Penn Central Railroad) running north-south, and passing along the western boundary of the site.

These transportation routes are shown on Figure 2.2-1.

Oil and natural gas pipelines located within five miles of the site are shown in Figures 2.2-1 and 2.2-4 and Table 2.2-2, and are described in Section 2.2.2.3.

There is one quarry, Pottstown Trap Rock Quarry Inc, located about 0.8 miles from the site. Operations at the quarry consist of blasting, crushing, grading, and storing lightweight rock. The location of the quarry is shown on Figure 2.2-2.

Industries located within 5 miles of the site are listed in Table 2.1-17. A further discussion is provided in Section 2.2.2.1. The locations and description of airports are provided in Section 2.2.2.5.

There are no military installations within 5 miles of the site.

2.2.2 DESCRIPTIONS

2.2.2.1 Description of Facilities

Industries within 5 miles of LGS, with ten or more employees, are listed in Table 2.1-17. The number of employees, products, and locations are listed for each establishment.

The industry nearest the site is the Pottstown Trap Rock Quarry, Inc. Operations at the quarry include the detonation of explosives in the process of quarrying stone. However, the use of explosives is infrequent, and only enough explosives are brought to the quarry for one particular application. There are no explosives stored on the quarry site. The maximum quantity of explosives detonated at the quarry at any time was (b)(4) Explosives are transported to the quarry by the blaster by truck via Route 422, Evergreen Road and Sanatoga Road. Other industries located within 1.3 miles of LGS include Hooker Chemical Company, Mahr Printing, Inc., Eastern Warehouses, Inc., Amerind-MacKissic, Inc., and Structural

2.2.2.6 Projections of Industrial Growth

Industry within 5 miles of the LGS site is clustered along the Schuylkill River, adjacent to rail lines and along major transportation arteries. The construction of the Schuylkill Expressway extension and planned improvements to the Pennsylvania Route 724 are expected to spur industrial development in these areas. At the intersection of the Schuylkill Expressway with the Collegeville-Trappe Route 422 bypass, a 1000 acre industrial park is planned. This area, when fully developed could employ 16,000 persons, assuming that 80% of the land would be developed at an average employee density of 20 persons per acre. New industrial areas are also planned near Route 724 in Spring City, East Coventry Township, and west of Pottstown Landing.

Pottstown Borough, in light of 1960-1970 population trends, may have reached a point of development saturation. Therefore, no significant increase in industry is anticipated in this area.

2.2.3 EVALUATION OF POTENTIAL ACCIDENTS

This section provides an evaluation of potential accidents in nearby transportation and industrial facilities, to determine what events need to be considered in the plant design. A description of design features to mitigate such events is also provided.

2.2.3.1 Determination of Design Basis Events

2.2.3.1.1 Explosions

Explosions can potentially occur due to accidents on the nearby railway line, highways, or pipelines, as identified in Section 2.2.2. There are no industrial activities involving explosive storage near the site.

The evaluation of potential railway explosions has been performed in conformance with Regulatory Guide 1.91 methodology. The maximum railway explosion is taken as one corresponding to (b)(4) which is equivalent to the explosion of a boxcar (b)(4) (b)(4) or a tank car (b)(4)

The frequency of boxcars, derived from a Bechtel study of hazardous materials that passed through the exclusion area during the period from March 1969 through May 1969, amounted to 1800 cars (i.e., 7200 cars per year). There were only (b)(4) that carried explosives.

The explosives are shipped in multiple boxcar shipments per train. However, no more than (b)(4) (b)(4) of explosives have been shipped at any one time. Normally, (b)(4) is shipped at any one time.

The safety-related structures of LGS are designed and constructed to withstand the effects of the design basis railroad explosion with no damage, and would be unaffected by any change in explosive shipment frequency.

Selection of a (b)(4) explosion model is conservative for the reasons given below. Information on explosives given below have been excerpted from the Bechtel Design Basis Railroad Accident Study. Additional information on the shipment of explosives through 1983 was obtained from ConRail, the American Association of Railroads, and the U.S. Department of Transportation.

(b)(4) box cars have been the most common size car used for shipping high explosives in the past. However, military shippers of high explosives prefer (b)(4) The use of (b)(4) cars has been infrequent and generally limited to items that move in (b)(4) shipments, such as (b)(4) Such cars are not loaded to capacity due to interior space limitations. In addition, the characteristics of commodities carried further limits the explosive power contained within the cars. For example, (b)(4) normally contain only (b)(4) (b)(4) by weight of explosive.

Thus, an (b)(4) (assuming (b)(4) for cases and packing) of (b)(4) would contain [redacted] (b)(4)
(b)(4) [redacted] of explosive. Applying a TNT equivalence factor of [redacted] ~~(for composition B)~~ and a (b)(4) (b)(4)
(b)(4) yields an explosion equivalent to (b)(4) of TNT. Thus, (b)(4) cars do not provide the limiting case; the LGS explosion magnitude model is adequate and conservative.

Explosive loadings consist of (b)(4) demolition blocks, etc. Demolition blocks provide the greatest concentration of explosive power in a car. (b)(4) etc, provide smaller concentrations of explosive power due to the heavy weight of (b)(4) (b)(4).

Composition C3 explosive, in the form of M5 demolition blocks, provides the greatest concentration of explosive power in a car. This explosive is more destructive than TNT, having a
(b)(4) ~~relative effectiveness factor of~~ [redacted] when compared with TNT. More powerful explosives were eliminated from consideration because they are shipped in (b)(4)

Military and commercial loading practices rather than accident history set the upper limit on the quantity of explosive considered. Car weight and volume capacities limit the maximum load. M5 demolition blocks are placed in boxes, loaded on pallets, and then blocked inside the rail car. (b)(4) boxes are loaded on a pallet, and (b)(4) pallets are loaded into a rail car. An aisle (b)(4) wide is down the center of the car, and a (b)(4) (b)(wide aisle connects the doors. A maximum of (b)(4) of composition C3 can be placed in the car.

Forty-four tons of composition C3 is equivalent in explosive power to (b)(4) of TNT. Application of a (b)(4) (b)(4) (b)(4) yields an explosion equivalent to (b)(4) of TNT.

The discussion above corroborates the selection of a (b)(4) TNT model as an upper limit on the design explosion. Consideration of the history of actual explosions confirms that the model is conservative. There is no evidence that an entire carload of explosives has completely detonated during the study period. There is evidence that the explosives will burn or partially detonate and scatter remaining car contents. At Tobar, Nevada and at Lewis, Indiana, some low and high order explosives occurred in the same car. Experts of the Bureau of Mines and the Army claim that the detonation of a carload is possible, but can only be assured if the explosive is detonated (b)(4) (b)(4)

For the above reasons, it is considered that the maximum explosion of a rail car carrying explosives would be equal to or less than the (b)(4) model used in the explosion and average reflected overpressure analysis for LGS.

The peak positive reflected pressures for which the critical structural elements of the safety-related structures were analyzed are given in Table 2.2-7. Missile generation from such an explosion is also postulated and is discussed in Section 3.5.

The effects of a release of (b)(4) of propane from a ruptured railroad tank car and subsequent detonation of the gaseous cloud which could occur at a distance of (b)(4) from the nearest portion of the Unit 1 reactor enclosure have also be(b)(4)d. Such an explosion could produce a peak reflected overpressure of approximately (b)(4) on the upper (b)(4) of the north, west, or south walls of the reactor enclosure. (b)(4) of the reactor enclosure and other safety-related structures nearby are protected from the explosion by the geometry of the topography between the river, the railroad grade, and the reactor enclosure. Such an explosion would take place at either railroad grade level or river level, due to the higher density of propane compared to air, especially after the gas has cooled during expansion from the liquid to gas phase. The shock wave of such an explosion exerts an overpressure for a duration of (b)(4) (b)(4) (Reference 2.2-15).

A structural analysis of the (b)(4) of the reactor enclosure has demonstrated that the enclosure can sustain the load without being damaged. A statistical analysis of the probability of an LPG tank car release and explosion was also performed based on methods described in Regulatory Guide 1.91 (Rev 1). This method utilized specific information on the number of LPG shipments past the LGS site. Credit was also taken for the fact that most LPG incidents occur in industrial installations or rail yards rather than on mainline track. The result of this analysis indicates a probability of approximately $5x10^{-9}$ for an LPG tank car release and explosion within a distance that could impact the LGS facility with an overpressure of 1 psi or greater. In 1981, according to Conrail, there were 1315 movements of LPG tank cars on the rail line that passes by LGS.

Explosions can also occur on nearby highways. However, since the railway is closer to the plant and truck cargo capacity is less than that of rail cars, the effects of a railroad explosion would be more severe than an explosion occurring on the highways.

An evaluation was conducted to determine the acceptability of the transportation route for the delivery of hydrogen gas via tube trailers to the Hydrogen Water Chemistry tube trailer facility located outside the protected area of LGS. The evaluation follows the Regulatory Guide 1.91, which provides guidance for providing safe separation distances between transportation routes, that may carry potentially explosive cargo, and safety related structures. The method for determining acceptable separation distance, determines the level of risk of damage due to the potential explosion of the cargo . Regulatory Guide 1.91 provides guidance for determining an acceptable level of risk. Based on industry data and site specific characteristics, the results of the risk evaluation indicated that the exposure rate is less than the value specified by Regulatory Guide 1.91. The transportation route for hydrogen gas delivery reflects an exposure rate that is of a sufficiently low risk of damage to nearby structures.

The potential also exists for the rupture of one of several nearby pipelines and the subsequent explosion of a gas or vapor cloud. The worst case overpressure due to a pipeline accident would involve the 20 inch Columbia Gas Transmission Company pipeline carrying natural gas.

Previous evaluations (Reference 2.2-2) indicate that natural gas will not detonate in unconfined spaces. However, to evaluate potential impacts, the detonation of a natural gas cloud from a rupture of the larger of the two Columbia gas pipelines gas been postulated. A detonable gas-air mixture approximately (b)(4) the requirement of Regulatory Guide 1.91 (Rev 1) is conservatively used to develop the explosive pressures for structural assessment. It has the equivalent explosive charge of (b)(4) of TNT. Furthermore, the detonation is assumed to occur at an elevation varying from ground to (b)(4) above ground to maximize the overpressures on the safety-related structures. In addition, the detonation is also assumed to occur anywhere along a line (b)(4) (b)(4) of and parallel to the route of the natural gas pipeline. This was done to maximize the explosion overpressures on each of the safety-related structures. The peak positive reflected pressures for which the critical structural elements of the safety-related structures were analyzed are given in Table 2.2-7.

The ARCO petroleum products pipeline is assumed to carry gasoline, which has the highest volatility and explosive power of the products carried in the line. The gasoline vapor concentration from the pipeline rupture and spill is postulated to reach the explosive limit (Reference 2.2-3) and has a TNT-equivalent energy of (b)(4) The centroid of the explosion is assumed to be along the Possum Hollow Run streambed. The distance to a safety-related structure from the point in the streambed which allows maximum exposure is (b)(4) measured from the Unit 2 reactor enclosure. The peak positive reflected pressure at the wall is (b)(4) and less than this value at the roof. This is the maximum overpressure from the gasoline explosion on the safety-related structures. The methodology used in calculating the overpressures in based on Reference 2.2-1.

As an example, the peak positive reflected pressure at the southwest corner of the Unit 1 diesel generator building (b)(4) s computed as follows:

R_G	=	Radial distance from charge = (b)(4)
W	=	Charge weight = (b)(4) (from page 4-8 of Reference 2.2-1)
Z_G	=	Scaled ground distance = $R/(W)^{1/3}$
	=	(b)(4)
P_{50}	=	Peak positive incident pressure = 6.0 psi
α	=	Angle of incidence = (b)(4) (from page 4-5 of Reference 2.2-1)
C_r	=	Reflected pressure coefficient = (b)(4)
P_r	=	Peak positive reflected pressure = $C_r \cdot P_{50}$
	=	(b)(4)

Because different locations of a wall will experience different peak positive reflected pressures, a critical element of a building wall is analyzed for the average of peak positive reflected pressures at the top and bottom of the wall element.

A low rate of leakage from the ARCO pipeline would likely be detected within (b)(4) the flow auditing and measurement procedures used at the pump stations along the pipeline. However, if such a leak were to occur and go undetected for a period of (b)(4) and if the pipeline transported gasoline (the most volatile substance carried), and if the leak were to be located in the vicinity of Possum Hollow Run, it can be anticipated that the gasoline would run into Possum Hollow Run and then flow downstream toward and into the Schuylkill River. Gasoline, with a (b)(4) ~~density of approximately~~ [redacted] compared to water, would form a thin monomolecular layer on the surface of the water flowing in Possum Hollow Run. No large accumulations or pooling would occur.

The worst situation for this type of release would be on a day during which ambient temperatures remain high because the evaporation rate of gasoline is more rapid at higher temperatures. For any gasoline spill, the lighter fraction components, notably butane, evaporate rapidly, while the heavier components such as naphthene evaporate more slowly. A summertime spill of a quantity of gasoline would evaporate completely within about (b)(4) but a wintertime spill could take a (b)(4) to evaporate completely.

If ignition were to occur, the fire would likely spread over the stream surface to all locations where the gasoline had reached, but excluding portions of the gasoline film that had become disconnected from the ignited portions by such means as flows over small waterfalls or by flows through pipes. After ignition, it can be expected that the ensuing fire could be fairly large in surface area along the creek surface, but would be of short duration. Because the gasoline is assumed to be of small initial quantity, continuous evaporation would occur, and there would be only a small amount of gasoline at any given point along the streambed due to the tendency of gasoline to form a thin surface film over water.

A double-ended rupture of the pipeline would be detected within seconds, and pumping would be terminated promptly. In the unlikely event that there was a complete rupture of the pipe and it went undetected for several hours, the severity of such an occurrence would be approximately the same as that described above for a gasoline spill where it was assumed that the contents of the pipeline between two adjacent high points of bank were spilled into Possum Hollow Run. This would amount to approximately (b)(4) f gasoline distributed along the creek bed, with an ensuing explosion (b)(4) from the plant, and a resulting overpressure of (b)(4)

The results of an explosion of gasoline vapor from a long-term continuous release of gasoline are assumed to be similar because gasoline released to the creek bed would be carried downstream into the Schuylkill River and would continue away from the plant.

The ARCO pipeline is an 8 inch line having a pumping capacity of about 1000 barrels per hour. A 1 hour release of gasoline would therefore amount of 42,000 gallons. The standing capacity of the creek bed (the quantity of fluid that would remain in the creek bed in pools if inflow were stopped) between the point where the pipeline crosses and its juncture with the Schuylkill River is small, so that a flow of gasoline at 42,000 gallons per hour, or 700 gallons per minute, would be expected to drain to the river quickly.

In the analysis of a gasoline spill, a point of detonation was used of (b)(4) from the closest Category I structure, occurring at a wide point in the streambed where the path to the reactor complex is relatively unimpeded by terrain. The bed of Possum Hollow Run passes closer to Category I structures, as follows:

(b)(4)

Unit 2 Diesel generator

Unit 2 Reactor enclosure

Turbine-generator building

Unit 1 Diesel generator

Unit 1 Reactor enclosure

Possum Hollow Run, at these closer points, flows through a fairly steep-walled ravine, which would serve to deflect and significantly lessen the effects of an explosion. For this reason, the (b)(4) distance selected is conservative.

Missile generation from the Columbia or the ARCO pipeline explosion would be less severe than from the railroad explosion because such a postulated explosion would take place in a cloud away from the postulated missile sources.

For the overall structural design and assessment of the critical structural elements of a safety-related structure, the highest values of the peak positive reflected pressures for walls and roofs are selected from the railroad, Columbia pipelines, and ARCO pipeline. The structural adequacy of the critical elements is evaluated against a ductility ratio of ~~All such safety-related~~ (b)(4) structures have been determined to be fully capable of withstanding these overpressures with no adverse effects.

2.2.3.1.2 Flammable Vapor Clouds

A pipeline rupture may occur in which the resulting vapor cloud burns rapidly (deflagrates) rather than detonates. Analyses that estimate the effects (radiant heat load) of such an event are discussed below for the ARCO gasoline pipeline. Other types of fires are discussed later in Section 2.2.3.1.4.

The same ARCO pipeline rupture discussed previously is assumed here. In this case, the available gasoline vapor is assumed to deflagrate. Worst case meteorological conditions were assumed, using Pasquill 'F' stability and (b)(4) wind speeds. Any other less stable category or higher wind speed would increase dilution of the gas or vapor cloud, and thus decrease the effect on the reactor enclosure. The resulting fire is calculated to produce a radiant heat load of (b)(4) (b)(4) (Reference 2.2-5) at the Unit 2 reactor enclosure for a short time. This level would produce a slight warming of the surface concrete. By comparison, a flat surface in the sun at midday receives solar radiation at approximately (b)(4)

In analyzing deflagration of natural gas released from a rupture of the Columbia Gas Transmission Company pipeline, it is assumed that the larger of the two lines (20") ruptures at the point where the pipeline passes closest to the Unit 2 reactor (b)(4) It is further assumed to be a double-ended rupture (complete separation of the pipe at the point of rupture).

A portion of the cloud downwind within flammable limits is assumed to ignite and deflagrate. The radiant heat load at the Unit 2 reactor enclosure is calculated to be about (b)(4) (Reference 2.2-5) for a short time. This level would cause a slight warming of the outer layer of concrete.

2.2.3.1.3 Exposure to Hazardous Chemical Releases

Exposure of control room personnel to hazardous chemical vapors could potentially result from an accident involving a chemical spill. Such spills could occur on the rail line, one of several highways close by, nearby industrial facilities, or from onsite chemical storage. A chemical is considered a potential hazard if it is stored or transported nearby in such quantities that its concentration at the control room air intake following a spill could exceed the toxic incapacitation concentration. Acceptable toxic incapacitation levels were based on compliance with the Regulatory Guide 1.78 requirement of 2 minutes for operator protective action, NUREG/CR-1741 incapacitation models (Reference 2.2-8), OSHA exposure limits, and ACGIH concentration criteria.

Potential chemical hazards were identified by first compiling a list of toxic chemicals that could pose a vapor hazard based on Regulatory Guide 1.78, NUREG-0570, and other sources. Surveys were conducted to determine which of these are actually stored or shipped within 5 miles of the LGS site, with what frequency, and in what quantities. For the railroads, ConRail provided information on which of these are shipped. Shipment frequency and quantity for those chemicals determined to be a hazard to control room operators are indicated in Table 2.2-6. Per Regulatory Guide 1.78, chemicals shipped less than 30 times per year are disregarded. For the highways, no centralized information source exists to determine what chemicals are shipped. A manufacturers and users survey was therefore conducted to ascertain potential shippers and receivers of hazardous chemicals. Various directories were used to identify such manufacturers in Pennsylvania and the surrounding states and users in the local area. Based on geographic location, competing highways, and direct routes, those manufacturers and users who would reasonably use the three highways near the site were contacted regarding chemicals shipped or received, routes, and container sizes. An analysis was then conducted to determine which of these chemicals, if spilled, could exceed toxic incapacitation levels in the control room. These are listed in Table 2.2-6, along with container sizes.

The analysis assumed complete release of the contents of a single container or tank. In accordance with Regulatory Guide 1.78, it was assumed that after an initial puff of vapor, any remaining liquid spreads over the ground and evaporates. The methodology of Regulatory Guide 1.78 and NUREG-0570 was used to model the initial puff and subsequent plume transport and dilution to the control room air intake. The control room concentrations were determined using the following control room parameters:

a. Control room envelope volume of (b)(4) as defined in Section 6.4.2.1.

b. 2100 cfm of incoming/outgoing air, based on the design outside air flow rate supplied by the normal control room HVAC system, as described in Sections 6.4.3.1 and 9.4.1.1.

c. Air intake 36.5 meters above ground, as indicated in drawing M-124 and Figure 6.4-2.

d. Inleakage rate of (b)(4) air changes per hour, during isolation, as discussed in Section 6.4.2.3.

e. (b)(4) time delay in the duct-work between the detectors at the control room intake plenum and the isolation valve at the entry into the control room air space, based on the air velocity in the duct during normal operation.

The consequences of an accidental release of phosgene gas, a combustion product of vinyl chloride, resulting from a fire in conjunction with an accident involving spillage of vinyl chloride were also evaluated. The phosgene concentration in the control room was calculated using the models of NUREG-0570 and the heat rise models of J.A. Briggs (Reference 2.2-9).

Chemicals stored onsite include carbon dioxide, nitrogen, and sulfuric acid, in quantities and at locations listed on Table 2 2-5.

As a result of the analyses, six potentially hazardous chemicals requiring monitoring were identified, as listed in Table 2.2-6. A brief description of each chemical and its effects on humans and laboratory animals are presented below:

<u>Ammonia</u>, NH_3

Ammonia is a colorless gas with sharp, intensely irritating odor. It has an odor threshold of 46.8 ppm for humans (Reference 2.2-13). Complaint levels of 20-25 ppm were first observed. Human effects such as eye irritation, sometimes with lacrimation, nose, throat, and chest irritation (coughing, edema of lungs), were found at concentrations up to 700 ppm, depending on exposure time (References 2.2-10, 2.2-11 & 2.2-12). The chemical then becomes lethal starting at 2,000 ppm concentration even for exposures at very short duration (Reference 2.2-10).

<u>Chlorine</u>, Cl_2

Chlorine in its gaseous form is greenish-yellow in color. It has a disagreeable, suffocating and irritating odor readily detectable at 3-5 ppm. Its effects on humans depend on the concentration. Irritant effects to eyes, nose, throat and/or face were noted at low concentrations. Effects on the upper and lower respiratory tracts and pulmonary edema were reported on exposures at high concentrations. It becomes highly dangerous to be exposed for 30 minutes at 40-60 ppm, fatal at concentrations of 833 ppm if breathed for 30-60 minutes, and rapidly fatal after a few breaths at 1,000 ppm (Reference 2.2-10). There were reports on effects of concentrations around 5 ppm causing respiratory complaints, corrosion of teeth, inflammation of mucous membranes of nose, and increased tuberculosis susceptibility (Reference 2.2-14).

<u>Ethylene Oxide</u>, C_2H_4O

Ethylene Oxide, a suspected carcinogen, is a colorless gas, sickening and nauseating at moderate concentrations and irritating at high concentrations. Humans exposed even to low concentrations showed delayed nausea and vomiting and at continued exposure, numbing of the olfactory sense. Inhalation at high concentrations resulted in general anesthetic effects as well as coughing, vomiting, and irritation of eyes and respiratory passages leading to emphysema, bronchitis and pulmonary edema (Reference 2.2-10). The lowest toxic concentration in humans through inhalation is 12,500 ppm for 10 minutes with only irritant effects observed (Reference 2.2-12). Odor threshold is 50 ppm for this chemical (Reference 2.2-13).

<u>Formaldehyde</u>, HCHO

Formaldehyde, a suspected carcinogen, is detectable by most people at levels below 1 ppm (References 2.2-11 and 2.2-14) and at 0.8 ppm (Reference 2.2-13). Humans experienced irritant effects on the eyes, nose, throat, and upper respiratory tract at concentration ranges of less than 1 ppm to 12 ppm. At high concentrations, a severe respiratory tract irritation which lead to death was reported on humans (Reference 2.2-14). Inhalation study on rats and mice showed that formaldehyde has a carcinogenic effect on rats. Rats developed nasal cavity squamous cell carcinomas after 12-24 months of exposure to 15 ppm, with deaths occurring during this period. Fatalities on rats were also observed at exposures to 81 ppm concentration (Reference 2.2-14).

Vinyl Chloride, $CH_2 \cdot CHCl$

Vinyl chloride is a colorless, toxic, highly flammable gas at room temperature and atmospheric pressure, with a pleasant, sweet odor at high concentrations (Reference 2.2-10). Evidence has shown it to be a carcinogen to persons exposed over extended periods of time (Reference 2.2-10). Exposure through inhalation at 200 ppm for 14 years showed occurrence of tumors on humans, carcinogenic effects at 500 ppm for 5 years (Reference 2.2-12). At concentrations above 1,000 ppm, vinyl chloride was reported to slowly affect a mild disturbance in humans such as drowsiness, blurred vision, staggering gait, and tingling and numbness in the hands and feet (Reference 2.2-10). The odor threshold for this chemical is 260 ppm (Reference 2.2-13).

Phosgene, $COCl_2$

Phosgene is a colorless, nonflammable, highly toxic gas at ordinary temperature and pressure, with a musty hay-like odor detectable at 0.5-2 ppm. It is a strong lung irritant and causes damage to the alveoli of the lungs. Inhalation of phosgene produces catching of breath, choking, immediate coughing, tightness of the chest, lacrimation, difficulty and pain in breathing, and cyanosis (Reference 2.2-10). Humans experience throat irritation at 3 ppm, immediate eye irritation at 4 ppm and coughing at 4.8 ppm. Brief exposure at 50 ppm may be rapidly fatal (Reference 2.2-11).

To ensure adequate protection of control room personnel, control room operators will be trained and periodically tested on their ability to put on breathing apparatus within 2 minutes after initiation of the toxic chemical alarm. Subsequently, the operators will manually isolate the control room as described in Section 6.4.3.2.3. If chlorine is detected with the control room HVAC System in the normal operating mode, automatic isolation of the control room will occur as described in Section 6.4.3.2.1.

If chlorine is detected with the control room HVAC system initially in the radiation isolation mode (as described in Section 6.4.3.2.2) because of testing or as required by the Action statement of the associated Technical Specifications Limiting Condition of Operation, the chlorine detectors would sense the presence of chlorine and initiate an automatic isolation of the control room outside air intakes, thus overriding the radiation isolation mode. However, the logic of the isolation signals with the control room HVAC system initially in the radiation isolation mode is such that a single failure of the chlorine detection system could allow the filtered outside air intake to remain open and thus the control room HVAC system would remain in the radiation isolation mode. Under these circumstances, once the chlorine has been detected and alarmed in the control room, manual action can be taken to realign the system to the chlorine isolation mode. Analysis of this event assumes that the system remains in the radiation isolation mode with 525 cfm of outside air being mixed with recirculated control room air for a total of 3,000 cfm being passed through the charcoal adsorber filter trains, and that the filter has no effect on removal of chlorine. The results of the analysis indicate that, with the control room HVAC system in the radiation isolation mode, the necessity for automatic chlorine isolation is not required to satisfy General Design Criterion (GDC) 19 of 10CFR50 of Appendix A, and that the control room operators would have sufficient time to don breathing apparatus after an alarm is sounded in the control room (as shown in Table 2.2-6).

Once it is confirmed that the isolation is not the result of elevated chlorine or toxic gas concentrations, the operators may remove their breathing apparatus. This action is based upon an evaluation of the chlorine and toxic gas accidents with the control room in the chlorine isolation mode prior to the chlorine or toxic gas accident. This evaluation determined that the control room operator would have sufficient time (more than 2 minutes) to don breathing apparatus after odor detection of the toxic substance.

The LGS toxic chemical analysis complies with the intent of Regulatory Guide 1.78. The analysis goes beyond the methodologies outlined in this guide in the following areas:

a. In addition to the chemicals listed on table C-1 of Regulatory Guide 1.78, other chemicals were investigated to determine if potential hazards existed. A total of 153 chemicals were evaluated.

b. The models of NUREG-0570 were used to determine the concentrations of hazardous chemicals in the control room.

c. The more stringent TLV levels were initially used instead of the Regulatory Guide 1.78 table C-1 toxicity limits to determine which chemicals were potentially hazardous. Table C-2 of Regulatory Guide 1.78 was not used to determine which chemicals were hazardous.

d. Potentially hazardous chemicals were re-evaluated using the incapacitation models of NUREG/CR-1741 (Reference 2.2-8) to determine if control room operations would be incapacitated. This analysis is an amplification of Position C.4 of Regulatory Guide 1.78.

2.2.3.1.4 <u>Fires</u>

In addition to the flammable vapor clouds discussed earlier, fire hazards may also exist due to a burning tank car on the railroad, a fire subsequent to a ruptured pipeline, or a nearby forest/brush fire. Potential adverse effects of such fires are radiant heat load on plant structures and smoke generation.

To estimate the effects of a railroad fire, an accident is hypothesized in which a railroad tank car derails, ruptures, and releases a cargo of (b)(4) of liquified propane. A (b)(4) car is typically the (b)(4) used for propane, and from a fire standpoint liquified propane represents one of the most severe materials transported by rail. The site of the hypothetical derailment is the closest point of approach to the Unit 1 reactor enclosure, (b)(4) The tank car propane is assumed to be released (b)(4) alongside the eastern side of the right-of-way, where it pools and is subsequently ignited. The vapor pressure of liquid propane is sufficiently high at ambient conditions that there will be an adequate supply of gaseous propane for ignition, after which the fire is self-propagating. The fire duration is assumed to be (b)(4) based on experience with this material.

Assuming 19,600 Btu per pound of propane and (b)(4) being consumed in (b)(4) the radiant heat load on the reactor enclosure may be calculated using the relationship (Reference 2.2-5):

$$D = (FQ/12.57K)^{1/2} \qquad \text{(EQ. 2.2-1)}$$

where:

D = distance, feet

F = fraction of heat that is radiant

Q = heat release, Btu/hr

K = radiation load, Btu/ft^2-hr

The result of this calculation indicates a radiant heat load of approximately (b)(4) (b)(4) at the Unit 1 reactor enclosure. This compares to a solar heat load for a flat surface at midday of (b)(4) The smoke effects of such a fire would be negligible. This accident represents the worst case radiant heat event. Other possible fires that result in more severe smoke generation are described below.

Rupture of the ARCO pipeline at Possum Hollow Run while carrying diesel fuel or home heating oil, which represents the worst case from a smoke generation standpoint, results in the release of approximately (b)(4) distributed over the streambed downstream toward the Schuylkill River. An open burning pool of oil produces (b)(4) per second of particulates (smoke) for each (b)(4) per hour of fuel consumed (Reference 2.2-5). The (b)(4) is assumed to be completely burned in a short time (b)(4) Assuming an average burn release of about (b)(4) of particulates per second over the 600 meter length from the streambed pipeline crossing to the first downstream bridge, concentrations of particulates at the reactor enclosure are approximately 2.60 grams of particulates per cubic meter. The radiant heat effects of such a fire are negligible.

A brush and forest fire in the vicinity of the LGS site releases 210 kilograms of particulates per hectare (Reference 2.2-7). Assuming a normal fire rate of 40 acres per hour along the southeast bank of Possum Hollow Run, the smoke concentration at the reactor enclosure, (b)(4) from the fire center, is approximately 0.6 grams per cubic meter.

The design provisions available if smoke reaches the control room ventilation are described in Section 2.2.3.2.

2.2.3.1.5 <u>Collisions with the Intake Structure</u>

The Schuylkill River is not used as a navigable waterway for anything other than small recreational boats. Moreover, the ultimate heat sink is the spray pond, so that damage to the intake structure does not impair safe shutdown capability.

2.2.3.1.6 Liquid Spills

Petroleum floating on the Schuylkill River surface could approach the intake structure due to a spill upstream. The intake is under water, so oil is excluded from entry into the intake line. The severest possible condition occurs at the design low water condition, with the water surface at (b)(4) The water intake is still submerged (b)(4) at this level. As noted above, the intake structure is not safety-related.

2.2.3.2 Effects of Design Basis Events

From the foregoing discussion, the following design basis events are identified, along with their potential effects:

a. Railroad, Columbia natural gas pipeline, and ARCO pipeline explosion - overpressurization and missile generation

b. Toxic chemical spill - hazardous control room concentrations

c. Propane tank car fire - radiant heat load on structures

d. ARCO pipeline fire - smoke in control room

The following design provisions or considerations account for these events:

a. Railroad, Columbia natural gas pipeline, and ARCO pipeline explosion

   1. Blast - safety-related structures are designed to withstand the resulting overpressurization due to an explosion as discussed in Section 2.2.3.1.1.

   2. Missiles - safety-related structures are designed to withstand the impact of blast-generated missiles, as identified and discussed in Section 3.5.

b. Toxic Chemical Spill

   1. Control Room - detection and isolation capability is provided for the 6 chemicals identified as constituting a hazard, as discussed in Section 6.4.

   2. Diesel Generators - The manufacturer of the emergency diesel generators has determined that the chemicals identified in Tables 2.2-5 and 2.2-6, when present in concentrations and for time spans calculated using the methodology described in Section 2.2.3.1.3, would have no adverse effects on diesel generator operation.

c. Propane tank car fire - the radiant heat load from such a fire is evaluated as having no adverse effect on safety-related structures. The bulk of the heat load would be absorbed by the precast panels on the face of the structures, which do not serve a safety function.

d. ARCO pipeline fire - smoke detectors in the control room intake alarm, and the operator can manually isolate the control room ventilation system, as discussed in Section 9.4.1.