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PG&E Letter DIL-03-010

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 72-26
Diablo Canyon Independent Spent Fuel Storage Installation
Additional Question Related to Supplemental Blasts and Explosions Responses to Additional NRC Questions for the Diablo Canyon Independent Spent Fuel Storage Installation Application (TAC No. L23399)

Dear Commissioners and Staff:

By letter dated December 21, 2001, the Pacific Gas and Electric Company (PG&E) submitted an application to the U. S. Nuclear Regulatory Commission (NRC) for a 10 CFR 72 site-specific license to build and operate an independent spent fuel storage installation at the Diablo Canyon Power Plant site. The application included a Safety Analysis Report, Environmental Report, and other required documents in accordance with 10 CFR 72.

PG&E Letter DIL-03-005, dated March 27, 2003, submitted additional information regarding blasts and explosions in response to additional NRC questions. The NRC has recently asked an additional question regarding blasts and explosions. The response to this question is included in Enclosure 1 to this letter. Enclosure 2 is Calculation PRA 01-01, Revision 5, which was revised to clarify and support the response to the additional NRC question.

If you have any questions regarding this response, please contact Mr. Terence Grebel at (805) 545-4160.

Sincerely,

Lawrence F. Womack

NMSS01

pns/4998
Enclosures

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PG&E Letter DIL-03-010

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of) PACIFIC GAS AND ELECTRIC COMPANY)) Diablo Canyon Independent) Spent Fuel Storage Installation)	) Docket No. 72-26

AFFIDAVIT

Lawrence F. Womack, of lawful age, first being duly sworn upon oath states that he is Vice President, Nuclear Services of Pacific Gas and Electric Company; that he is familiar with the content thereof; that he has executed this supplemental response to an additional NRC blasts and explosions question regarding the Diablo Canyon Independent Spent Fuel Storage Installation license application on behalf of said company with full power and authority to do so; and that the facts stated therein are true and correct to the best of his knowledge, information, and belief.

Lawrence F. Womack
Vice President Nuclear Services

Subscribed and sworn to before me this 28th day of July 2003.

Sandra L Rector

Notary Public
State of California
County of San Luis Obispo

SANDRA L. RECTOR
Commission # 1339380
Notary Public - California
San Luis Obispo County
My Comm. Expires Jan 12, 2006

PG&E Response to an Additional NRC Question Related to Blasts and Explosions for the Diablo Canyon ISFSI License Application

<u>NRC Questions:</u>

According to the Probabilistic Risk Assessment (Letter from Lawrence F. Womack to the U.S. Nuclear Regulatory Commission, PG&E Letter DIL-03-005, Enclosure 2, March 27, 2003), the annual frequency of occurrence for a potential explosion of the Diablo Canyon Power Plant (DCPP) Unit 2 transformers while the HI-TRAC 100 transfer cask is in violation of the requisite setback distance is 5.88 x 10^{-8} per year. This frequency of occurrence, however, was calculated assuming (i) a total exposure time of 10 hr and (ii) geometric factors that appear to be more relevant to calculating the potential consequences to the transfer cask in the event an explosion were to occur. As pointed out in the PRA, the actual exposure time for the transfer cask to the transformer explosion hazard is approximately 23 min (0.383 hr) per trip. Allowing for 8 trips per year, the total annual exposure time is approximately 3.07 hr. Using the transformer failure rate provided in the PRA, the annual frequency of occurrence of a potential explosion of the 500 kV Single Phase Transmission transformer is:

$r_{500\,kV}$ = *(2.6 x 10^{-7} failures per hour per transformer) x (3 transformers) x (3.07 hr/yr) = 2.4 x 10^{-6} failures per year.*

Similarly, for the 12 - 25 kV Three Phase Transmission transformer

$r_{12-25\,kV}$ = *(6.6 x 10^{-7} failures per hour per transformer) x (3 transformers) x (3.07 hr/yr) = 6.1 x 10^{-6} failures per year.*

Summing these annual frequencies of occurrence indicates a rate of approximately 8.5 x 10^{-6} failures per year of the Diablo Canyon Power Plant (DCPP) Unit 2 transformers while the HI-TRAC 100 transfer cask is in violation of the requisite setback distance. This frequency rate exceeds the 10^{-6} occurrence rate established in Regulatory Guide 1.91 as the threshold for screening out a potential hazard when using conservative assumptions. Therefore, the frequency of occurrence must be recalculated using justifiable assumptions to show that the 10^{-6} threshold is not exceeded, or a consequence analysis for this scenario should be provided.

<u>PG&E Response:</u>

The data used in the PRA 01-01 Revision 4 calculation for the probability of an explosion of a transformer was very conservative and is based on industry data on catastrophic failure of the transformers from any cause. For this data, catastrophic failure is defined as no output due to; automatic removal by protective circuitry, manual removal, and open circuit. Conservatively this data was used in PRA 01-01, because PG&E was not able to locate specific industry data on transformer explosions.

The geometric factor provided in the PRA calculation was based on the exposure profile of the cask during transport for a transformer explosion blast that could potentially exceed 1 psi. This geometric factor, used in the PRA 01-01 Revision 4, accounts for elevation changes, set back distance, and shielding. The use of this geometric factor was considered to be appropriate to account for the potential effects of a blast from any transformer.

As stated above the evaluation of transformer explosion hazard that is documented in PRA 01-01 Revision 4 is highly conservative. However, after further review of the potential threat from transformer explosion, PG&E has determined that, a vapor cloud type explosion that would develop a pressure wave greater than 1 psi at a minimum distance of 240 feet is not credible. Therefore, transformer explosion can be screened out as a source of hazard to the HI-TRAC 125 transfer cask and there is no need to calculate occurrence frequency. This basis for this determination is provided below.

The DCPP transformers are filled with mineral oil and as discussed in the Safety Analysis Report (SAR) Section 8.2.6, the flash point of mineral oil is 275°F. To be classified as flammable the flash point of a liquid must be less than 100°F as discussed in the National Fire Protection Association Handbook. The normal operating temperature of the 13,000 gallons of mineral oil in each of the DCPP main bank transformers is approximately 160°F. This temperature is considerably less than the flash point of mineral oil. Therefore, under ambient or normal operating temperature, this material does not represent a credible fire or explosive hazard.

Review of the industry data on transformer failures does not identify any cases where a vapor cloud type explosion was involved in or was the result of any transformer failure. It does identify that the failure mechanisms for the transformers sometimes involve a pressure increase internal to the transformer caused by a fault, which results in a rupture of the transformer case. In these cases, once the case is ruptured the mineral oil may ignite and burn.

In support of this industry data, DCPP has experienced one transformer fire during its operating life. In that event, an auxiliary transformer was subject to a severe system short. As a result of that short the transformer became pressurized to the point of rupturing the transformer case and spilling out the mineral oil contained within it. Once outside of the case the mineral oil did ignite in a fire.

Although this event did involve a rupture of a welded seam on the transformer case, this rupture was determined to be the result of a pressure spike inside the transformer caused by the large amount of heat from the short circuit and not from an ignition explosion. This would be considered an expected result from a severe short circuit. In this event, although there was a pressure release by the rupture, the damage caused was minimal, and only involved the transformer case and some of the fire system piping in the immediate area of that transformer. There was no vapor cloud type ignition explosion of the mineral oil. However, the oil did catch fire and burn locally to the transformer.

Based on the high flash point of mineral oil, the lack of industry data in support of vapor cloud type explosions, and the DCPP operating experience, PG&E believes that the transformers are not a credible vapor cloud explosion hazard that would result in a pressure greater than 1 psi that could impact the transporter and require no further analysis. However, PG&E does consider that there is a possible fire hazard and that the design basis fire for the transfer cask would bound any fire from the transformers. This is based on the minimum distance to the transporter, a dedicated transformer fire suppression system, and a difference in elevation between the transformers and the transporter route.

The transformers are approximately 240 feet from the transporter at its closest point during transport. The transformers are surrounded by a dedicated fire suppression system that will act to control and minimize any fire that could potentially occur. There is also a 30-foot difference in elevation between the transporter route and the transformers that will not allow oil from a transformer to approach within approximately 120 feet of the transporter.

In addition, although a fire from a transformer is considered bounded by the design basis of the transporter and not an unacceptable hazard, in an effort to further minimize its probability, PG&E is taking prudent actions to minimize the transformer fire hazards during transport as follows:

The causes of a transformer failure include both internal and external sources. The internal sources are electrical in nature and the external cover both natural sources, such as lightning, and man made such as vehicle crashes. The two most likely external sources would be vehicle crashes and lightning strikes. The vehicle hazard will be controlled by administrative procedures that do not allow any vehicle motion in the vicinity of the transformers during transport operations. In addition, administrative procedures will be in place that will not allow transport of fuel when severe weather (which could result in lightning or other hazards) exists or is predicted to occur in the vicinity of the DCPP plant site. Therefore, a transformer fire caused by an external event during transportation is not a credible event.

For the internal sources, although failures can happen in any mode of operation, the probability of transformer failures is higher during transition operations, such as would take place during plant outages. PG&E administrative procedures will consider offsite power conditions prior to transport operations in the vicinity of the Unit 2 transformers.

Based on the above discussion, the potential hazard of explosion from the transformers is not considered to be credible; however, it is considered a fire hazard that is bounded by the design basis fire analysis for the transfer cask. The SAR Sections 2.2, 8.2.5 and 8.2.6 will be revised to remove the transformer explosive hazard and clearly identify the fire hazard and summarize the above evaluation.

Enclosure 2

PACIFIC GAS & ELECTRIC COMPANY

PROBABILISTIC RISK ASSESSMENT

CALCULATION FILE NO. **PRA01-01 Revision 5**

SUBJECT: Risk Assessment of Dry Cask/Spent Fuel Transportation within the DCPP Owner Controlled Area

PREPARED BY: ______________________ DATE: 7/24/03
D. F. Spaulding

VERIFIED BY: ______________________ DATE: 7/24/03
K. A. Hubbard

VERIFIED IN ACCORDANCE WITH: CF3.ID15

APPROVED BY: ______________________ DATE: 7/24/03
A. Afzali

NOTE: This Document contains assumptions and results that are the basis for parts of SAR Sections 2.2.2.3 and 8.2.6, Modification of this document will require evaluation under 10CFR72.48.

This file contains: 17 pages including Attachment 1 & 2

RECORD OF REVISIONS

REV. 0 Original Calculation.

REV. 1 In this revision, the risk of damage to dry casks due to explosion of an acetylene carrying truck is added to the analysis of risk of damage due to other hazards. This is done to support response to RAI 15-12.

REV. 2 In this revision, the date of the final HI-TRAC evaluation was changed to reflect the actual issuance date (March 6, 2001). The February 2001 date was a preliminary draft, which was the version available at the time this PRA calculation was initially issued (Revision 0 dated February 28, 2001).

REV. 3 In this revision, the evaluations have been revised to address the RG 1.91 1 PSI criteria where possible, to use more up to date vehicle crash data, and to clarify the previous evaluations.

REV. 4 In this revision, the evaluations have been revised to clarify various exposure distances, to reduce the average onsite gasoline powered vehicle fuel tank size to 20 gallons, replace the 2000-gallon fuel truck with a new 800-gallon fuel truck which is now being used, and clarify the evaluation of gas bottles passing by the ISFSI. Reference 9 provides updated information on hazardous materials being transported by the ISFSI.

REV. 5 Removed evaluation of transformer explosion as it was determined not to be a credible hazard per PG&E letter DIL-03-010.

INTRODUCTION

Per the requirements of RG 1.91, Revision 1, explosive hazards in transit are to be evaluated to ensure that there is no significant potential for damage to any safety related components. This RG also provides guidance that allows determination of risk based on location and amount of the hazard. When using a potential design limit of 1 psi for a component, if the risk is found to be less than 10^{-6} using conservative data or less than 10^{-7} using more site-specific data, then the risk is considered non-significant and acceptable. The methodology in the RG allows a hazard to be dismissed as non-significant if the 1 psi criteria is met based on a setback distance and volume of hazard. However, if the setback distances or volume of a hazard will potential exceed the 1 psi criteria the RG requires further evaluation based on probability and risk. Based on this the RG guidance risk evaluations were performed to assess the risks of an explosion causing damage to the dry casks while being transported, or while the casks are stored at the Independent Spent Fuel Storage Installation (ISFSI). As a result, several explosion sources were identified that potentially don't meet the setback and volume limitations and required further evaluation. Specifically, five bounding explosion sources were identified requiring this risk evaluation:

1. An explosion of a parked vehicle's fuel tank while the HI-TRAC transporter is passing on the road near or through the parking lots on its route to the ISFSI.

2. A hydrogen explosion in the protected area from the hydrogen tanks while the HI-TRAC transporter is in the vicinity.

3. An explosion of a 800-gallon fuel truck while it passes within 600 feet of the ISFSI facility.

4. Explosion of one of the 140 vehicles per day (with an average of 20 gallons of gasoline) that pass within 175 feet of the ISFSI facility.

5. An explosion at various compressed gas cylinder storage facilities and the movement of propane or acetylene bottles past the ISFSI area.

In addition, similar hazards that are potentially transported by different means are summed in this calculation to show the total exposure potential for that hazard per RG 1.91.

DISCUSSION

One of the requirements in the Diablo Canyon Spent Fuel Storage Installation (ISFSI) Safety Analysis Report (SAR) is the evaluation of explosions. During the evaluation process, five bounding potential explosion hazards were identified as needing a risk evaluation to ensure that they meet the RG 1.91 1 psi limit, or that they are acceptable risks per the methodologies provided in RG 1.91. These five explosion hazards are:

1. Explosion of a parked vehicle, while the HI-TRAC transfer cask transporter is passing in the vicinity of the parking lots.

2. Explosion of the bulk hydrogen storage facility while the cask transporter is in the area.

3. Explosion of one of the 800-gallon fuel trucks while the truck is passing within 600 feet of the ISFSI facility.

4. Explosion of one of the 140 vehicles per day (with an average of 20 gallons of gasoline) that pass within 175 feet of the ISFSI facility.

5. Explosion of various compressed gas cylinder storage facilities and the explosion of propane or acetylene bottles moving past the ISFSI facility.

ACCEPTANCE CRITERIA

Regulatory Guide 1.91 (Reference 1) contains guidance on acceptable risk from explosions for nuclear plants. Regulatory Guide 1.91 states, "If estimates of explosion rate, frequency of shipment, and exposure distance are made on a realistic or best estimate basis, an exposure rate less than 10^{-7} per year is sufficiently low. If conservative estimates are used, an exposure rate less than 10^{-6} is sufficiently low."

ASSUMPTIONS

1. It is estimated that there will be eight shipments per year of the HI-TRAC transfer casks from the spent fuel building to the ISFSI.

2. The hydrogen tanks will not be filled, tested or vented while the HI-TRAC transfer cask transporter is in the vicinity of the hydrogen tanks. (Ref: AR A0524878)

3. Additional physical barriers will be erected to prevent the transporter from getting too close to the hydrogen tanks. (Ref: AR A0524878)

4. The 800-gallon trucks will be maintained at least 600 feet from the transporter path during spent fuel transport. See Assumption 6 below for specific setback required to meet RG 1.91 criteria of 1 psi. (Ref: AR A0524878) Note: The 2000-gallon truck is no longer being used and has been replaced by an 800-gallon truck. (Reference 9)

5. A 800 gallon truck will pass by the ISFSI facility six time per week. This is based on three round trips per week. (Reference 9)

6. The 800-gallon truck does not stop within 600 feet of the ISFSI. Administrative controls will designate parking areas for this vehicle. However, if there is a mechanical breakdown within the 600 feet of the ISFSI, administrative controls will require immediate removal to its designated parking area or to a distance of greater than 600 feet from the ISFSI. (Ref: AR A0524878).

   The setback distance is based on the maximum amount of gasoline in the truck being 800 gallons. Using the RG 1.91 methodology, reference (1) the required setback or separation distance (at which the pressure wave is equal to or less than 1 psi) can be calculated.

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

   Where R is the setback in feet
   W_{tnt} is the explosion hazards in equivalent pounds on TNT
   k is 45 when R is in feet and W is in pounds

   Using the formula in reference (2) section 1) for 4000 gallons to determine the equivalent lb-TNT and using a 800 gallons capacity,

W_{tnt} = 11770.6 * 800/4000 = 2,354.12 lb-TNT

And

$R \geq (45)(2,354.12)^{1/3}$
$R \geq$ 598.63 feet in setback or separation distance
(Note: 600 feet will be used in this evaluation)

Note: the W_{tnt} calculated in reference (2) is conservative as it assumes "that 100% of the liquid has been vaporized and mixed with air between the upper and lower flammability limits" and that "No credit for partial shielding between the casks and the location of the explosion is considered."

7. The speed of all vehicles in the area of the ISFSI will be administratively controlled to less than 25 miles per hour. (Ref: AR A A0524878)

8. No vehicles will be allowed to pass the 800-gallon truck in either direction while it is in the 600 foot exclusion area around the ISFSI facility. (Ref. AR A0524878)

9. All gasoline powered vehicles, which must pass within 175 feet from the closest point of an ISFSI pad will be under administrative controls. The administrative controls will control speed, movement and provide designated parking areas outside the 175 foot setback distance for these vehicles. If there is a mechanical breakdown within the 175 foot setback distance, administrative controls will also require immediate removal to its designated parking area or to a distance of more than 175 feet from the ISFSI. (Ref: AR A0524878)

   The setback distance is based on the average amount of gasoline in any onsite vehicle fuel tank which is conservatively assumed to be 20 gallons. Using the RG 1.91 methodology the required setback or separation distance (at which the pressure wave is equal to or less than 1 psi) can be calculated.

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

   Where R is the setback in feet
   W_{tnt} is the explosion hazards in equivalent pounds on TNT
   k is 45 when R is in feet and W is in pounds

   Using the formula in reference (2) section 1) for 4000 gallons to determine the equivalent lb-TNT and using 20 gallons as the average tank capacity,

   W_{tnt} = 11770.6 * 20/4000 = 58.85 lb-TNT

   And

$R \geq (45)(58.85)^{1/3}$
$R \geq 175$ feet in setback or separation distance

Note: the W_{tnt} calculated in reference (2) is conservative as it assumes "that 100% of the liquid has been vaporized and mixed with air between the upper and lower flammability limits" and that "No credit for partial shielding between the casks and the location of the explosion is considered."

10. It is assumed that no more than 140 gasoline-powered vehicles per day will pass by the ISFSI facility. The actual number of vehicles that pass the ISFSI facility per day is approximately 50 vehicles and they pass it in two directions. However, 140 vehicles was used to be conservative.

11. The 4000-gallon fuel truck will be not allowed in the owner-controlled area during spent fuel transport. (Reference 2) (Ref: AR A0524878)

12. Administrative controls will prevent the 4000-gallon truck from moving up the hill and passing by the ISFSI facility. (Ref: AR A0524878)

13. Physical and administrative controls will be in place to prevent vehicle movement within 175 feet of the moving cask transporter. (Ref: AR A0524878)

14. The cask transporter, while loaded with a HI-TRAC transfer cask, will be in the vicinity of the bulk hydrogen storage facility less than 1 hour during each shipment from the spent fuel building to the ISFSI facility.

15. The cask transporter, while loaded with a HI-TRAC transfer cask, will be in the vicinity of the parking lots less than 1 hour during each shipment from the spent fuel building to the ISFSI facility. This estimated time is very conservative considering that the total exposure distance as a result of the travel route of the transporter in the parking lots (which are located within 175 feet of the transport route and which could impact the transporter from an explosion, i.e., no intervening buildings or elevation differences) is approximately 1000 feet, the transporter moves at about 0.4 mph, and the transporter will pass straight through these areas with minimal maneuvering required. At the 0.4 mph speed the transporter would be in the area less than 30 minutes. This time has been doubled to be conservative in this evaluation.

16. Administrative Procedure AD4.ID1 requires that all bottles within the RCA and outside the protected area will be appropriately secured and chained so they are not hazards. A walkdown will occur prior to the transporter beginning its trip, from the Spent Fuel Pool Building to the ISFSI, to confirm the bottles are appropriately chained. (Ref: AR A0524878)

17. Walkdowns will occur in the parking lots, which have the potential to affect the transportation route, to assure that no potential explosive hazards (such as leaking

gasoline tanks) exist prior to any movement of the loaded cask transporter in the vicinity of these parking lots. (Ref: AR A0524878)

18. Additionally, a walkdown will occur outside the protected area prior to movement of the cask transporter, while loaded with a HI-TRAC transfer cask, to evaluate any transient hazardous material located along the pathway. (Ref: AR A0524878)

19. It is assumed that all gas bottles transported past the ISFSI facility will be appropriately secured in the upright position within the transporting vehicle.

CALCULATIONS

Hydrogen Tank Explosion

The bulk hydrogen facility contains 6 hydrogen tanks. The hydrogen tanks and hydrogen piping contain relief valves, which are vented to atmosphere. Because of the design, a hydrogen explosion is not considered credible. However, hydrogen fires are credible, and appear in the EPRI Fire Events Database (Reference 5), including fires caused by a stuck open or leaking relief valve.

The EPRI Fire Events Database gives an annual frequency of Hydrogen fires of 3.2e-3/year (Reference 5). It is conservatively assumed the entire frequency of fires can be assigned to the bulk tank facility. Thus, the hourly frequency of hydrogen fires at the bulk tank facility is:

Hydrogen Fire Frequency = 3.2e-3/yr * yr/8760 hrs = 3.7e-7/hr

Because of the design of the hydrogen system, which does not allow hydrogen to accumulate in confined spaces, there is an extremely low probability of a hydrogen explosion, even if a hydrogen fire occurs. If we conservatively assume a conditional probability of 0.1 that a hydrogen explosion occurs, given a hydrogen fire has occurred, then the Hydrogen Explosion Frequency is:

Hydrogen Explosion Frequency = 3.7e-7/hr * 0.1 = 3.7e-8/hr

The hydrogen explosion is a concern when the HI-TRAC transfer cask transporter is in the vicinity of the hydrogen tanks. As noted in the assumptions section, the transporter should be in the vicinity of the hydrogen tanks less than 1 hour for each shipment, with eight shipments per year. It will be assumed that the transporter will be in the vicinity of the hydrogen tanks a total of 10 hours per year. This assumption is very conservative because the hydrogen facility is a vault that is open on one side only. The open side is where the transporter passes. Because of the configuration of the area around the vault the transporter is only exposed to the potential of an explosion as it passes directly in front of the open end of the vault. The vault open end is less than 30 ft across and at the normal speed of the transporter it will be exposed for less than two minutes per trip. However, conservatively the calculation has used 10 hours per year.

On a yearly basis, the probability (exposure rate) of a hydrogen explosion potentially damaging the HI-TRAC cask is:

3.7e-8/hr * 10 hr/yr = 3.7e-7/yr

According to Regulatory Guide 1.91, "if conservative estimates are used, an exposure rate less than 10-6 per year is sufficiently low."

<u>800 Gallon Truck Explosion</u>

There is data available from the Department of Transportation on truck crashes and truck fires. Table 38 of the 2001 NHTSA statistics (Reference 6) show that in 2001 large trucks were involved in 429,000 crashes. Table 1 of the 2001 FMCSA data (Reference 7) shows that in 2001 large trucks traveled approximately 207,686 million miles. This results in a "Large trucks involvement rate" of 207 per 100 million miles. This data includes crashes from all hazards including weather and natural causes.

Per the assumption that no other vehicle will be traveling near the ISFSI when the 800-gallon truck is in motion it is assumed that only a single vehicle accident can occur. Based on Table 46 of the 2001 NHTSA statistics (Reference 6), single vehicle crash data, shows a total of 96,000 crashes occurred in 2001, which is approximately 22 percent of all large truck crashes.

Per the listed assumptions the speeds in the area of the ISFSI are to be controlled below 25 miles per hour at all times. Based on this, Table 29 of 2001 NHTSA statistics (Reference 6) shows that for all single vehicle crashes approximately 31 percent are less than 30 miles per hour. Although there is no specific data provided for large trucks as compared with all vehicles, for our calculations we are conservatively assuming that for trucks it is similar to the single vehicle crash percentage which is 31 percent of all accidents are at less than 30 miles per hour,

Although the Table 29 data does not provide a direct correlation between the large truck data and the all vehicle data, the use of 31 percent is believe d to be reasonable. In support of this assumption, Table 26 of the 2001 FMCSA data (Reference 7) provides data that shows that the percentage of fatal crashes involving a single large truck at 25 miles or less is about 6.8 percent of all fatal large truck crashes. Table 29 of 2001 NHTSA statistics (Reference 6) shows that for all fatal single vehicle crashes approximately 13 percent are at less than 30 miles per hour. For speeds above this level the percentage of fatal accidents involving large trucks continues to remain below the percentage for all vehicles. Based on this trend it is reasonable to consider that the percentage of single large truck accidents under 30 mph will remain below the percentage for all vehicles crashes. However, to ensure this is conservative this evaluation used a 31 percent figure as discussed above.

Table 38 of the 2001 NHTSA statistics (Reference 6) shows that 0.5 percent of all large truck crashes result in fires. Thus, the frequency of truck fires is:

(207 * 0.22 * 0.31 / 100e6) *0.005 = 7.061e-10/mile

For the purposes of this analysis, it is conservatively assumed that all truck fires result in an explosion. Thus, the explosion rate for truck fires is 7.06e-10/mile.

Regulatory Guide 1.91 provides the following equation for use in the evaluation of explosions:

r = nfs, where

n= explosion rate for the substance and transportation mode in question in explosions per mile
f = frequency of shipment for the substance in question in shipments per year, and
s = exposure distance in miles

It is assumed that the ISFSI exposure distance, s is conservatively 2300 feet based on a 600 foot exclusion area from the nearest cask. This exposure distance is limited on the west and south sides of the ISFSI by an elevated hillside, which limits line-of-sight to the roadway. As noted above in the assumptions section, the frequency of shipments is 6 times per week, or 312 per year.

Thus, r = (7.06e-10/mile) * 312 * 2300/5280 = 9.59e-8/year

Note: This is conservative because we are assuming that all vehicle fires lead to an explosion

<u>20 Gallon Gasoline Powered Vehicle Explosion near ISFSI</u>

There is data available from the Department of Transportation on all vehicle crashes and all vehicle fires. The 2001 National Statistics summary of the NHTSA statistics (Reference 6) show that in 2001 all motor vehicles were involved in 6,323,000 total crashes. It also shows that motor vehicles traveled approximately 2,781,462 million miles. This results in a "vehicle involvement rate" of 227 per 100 million miles." This data conservatively include all motor vehicles including large trucks and from all hazards including weather and natural causes.

Per the assumption that vehicle travel will be limited within the 175 feet setback distance from the closest part of the ISFSI facility and will result in no vehicle being allowed to pass another vehicle within that setback distance As a result, only a single vehicle accident can occur. Based on this Table 29 of the 2001 NHTSA statistics (Reference 6) provides single vehicle crash data, which shows a total of 1,907,000 crashes in 2001, which is approximately 30 percent of all vehicle crashes.

Per the listed assumptions the speeds in the area of the ISFSI are to be controlled below 25 miles per hour at all times. Based on this, Table 29 of 2001 NHTSA statistics (Reference 6) shows that for all single vehicle crashes approximately 30 percent are less than 30 miles per hour.

Table 38 of the 2001 NHTSA statistics (Reference 6) shows that 0.1 percent of all vehicle crashes result in fires. Thus, the frequency of vehicle fires is:

227 * 0.30 * 0.30 / 100e6 * 0.001 = 2.04e-10/mile.

For the purposes of this analysis, it is conservatively assumed that all vehicle fires result in an explosion. Thus, the explosion rate for vehicle fires is 2.04e-10/mile.

Regulatory Guide 1.91 provides the following equation for use in the evaluation of explosions:

r = nfs, where

n= explosion rate for the substance and transportation mode in question in explosions per mile
f = frequency of shipment for the substance in question in shipments per year, and
s = exposure distance in miles

It is assumed that the ISFSI exposure distance, s is approximately 300 feet as shown in attachment 2. The exposure distance on the southwest side of the ISFSI is limited by an elevated hillside which limits line-of-sight to the roadway. The exposure distance reflects the exposure of any cask at the ISFSI facility from this hazard on while this hazard in on the roadway and within the setback of 175 feet distance.

As noted above in the assumptions section, the frequency of 140 per day, or 51,100 per year.

Thus, r = 2.04e-10/mile * 51,100 * 300/5280 = 5.92e-7/year

Summing the potential exposure rates from a gasoline hazard for the ISFSI facility per RG 1.91:

Total potential exposure = 9.59e-8/year + 5.92e-7/year = 6.88e-7/year

According to Regulatory Guide 1.91 Revision 0, if conservative calculations are used, an exposure rate, of less than 1e-6/year is acceptable.

For explosions from gasoline hazards at the ISFSI, all of the above date and results are very conservative as they are based on national highway statistics and do not take into consideration the very controlled nature of the activities at the ISFSI, the limited maneuvers performed by any vehicle in the area of the ISFSI, the normal speeds which are below 25 miles per hour, the over stated potential for fires resulting in explosions, and the number of vehicles in the area.

Parked Vehicle Explosion Risk

Vehicle (defined as non-large truck) explosions almost always are the result of a crash or collision, and rarely, if ever, occur in parked vehicles. Based on the known history of DCPP there has been only one fire in a vehicle in the parking lots. That fire ignited at the time the car was being started and occurred in the ignition system. That fire would not be considered a credible scenario during fuel transport because of administrative controls that will be in place as follows:

Prior to a loaded transporter being moved in the vicinity of a parking lot, administratively controlled walk downs of the parking lots will be performed looking for any possible fire or explosion hazards such as leaking gasoline.

During the transportation of the HI-TRAC transfer cask, administrative and physical controls will be in place to prevent vehicles from moving within 175 feet of the transporter, while it is in the vicinity of the parked vehicles.

With these controls in place the only possible explosion scenario is spontaneous combustion of a parked car. This event is not considered credible.

In support of this conclusion, a search was conducted for industry data concerning the frequency of explosions of parked vehicles. However, no industry information of this type was found. However, to be conservative the following analysis was performed.

Per the previous analysis of a 20-gallon vehicle, it was determined that the frequency of fires/explosions in a single moving vehicle crash is 2.04e-10/mile. Since none of the parked cars are moving or allowed to move within 175 feet of the transporter and the event is not considered credible, reducing this frequency by a factor of ten is considered reasonable and very conservative.

Regulatory Guide 1.91 provides the following equation for use in the evaluation of explosions:

$r = nfs$, where

n= explosion rate for the substance and transportation mode in question in explosions per mile
f = frequency of shipment for the substance in question in shipments per year, and
s = exposure distance in miles

The frequency (s) of shipment in the assumption section is 8 trips will be made per year. It is assumed that the ISFSI exposure distance, s is conservatively 1000 feet. In addition, it is estimated that a maximum of 200 vehicles will be within that 175 feet setback distance at any moment while the transporter is moving through the exposure distance.

> Thus, conservatively r = exposure rate * frequency * exposure distance *number of exposure vehicles = 2.04e-11 * 8 * 1000/5280 * 200 = 6.18e-9

Note: This is conservative because we are assuming that all vehicle fires lead to an explosion and we are using moving vehicle explosion rates for stationary vehicles.

According to Regulatory Guide 1.91 Revision 1, if conservative calculations are used, an exposure rate, of less than 1e-6/year is acceptable.

Gas Bottle Explosion

There are no storage facilities for explosive gases within 1000 feet of the ISFSI facility and the uses for these gases are very limited within that distance. Based on recent discussions with the DCPP personnel there is some cutting requiring a touch is done at the maintenance facility east of the ISFSI and they do use propane powered forklifts occasionally at that facility. These forklifts use a 7-gallon propane bottle. Per these discussions, it was also determined that less than one acetylene bottle is bought by the ISFSI per year and that less then one single propane bottle per week passes the ISFSI. The estimate of the propane movement is based on both the actual movement of a spare propane bottle in a truck or the movement of the forklift itself. The movement of the forklift is controlled under the same administrative controls for large trucks in the area of the ISFSI.

The movement of the propane and acetylene bottles past the ISFSI facility will be controlled through administrative procedures. These procedures will not only control the amount of gas being transported, but how it is physically restrained during transport to ensure limited potential for failure.

Explosions or failures of any type involving compressed gas bottles usually are caused from valves being broken or the bottles being pierced by some external object. These types of failures require some motive force and are considered to be limited in the case of the area around the ISFSI to a vehicle crash. In addition, because of the limitations on vehicle motion the possibility of a crash is limited further to single vehicle crashes similar to the large truck evaluation, which was found to be 9.59e-8/year in this calculation. If we conservatively consider that every truck crash causing a bottle failure that will potentially affect the ISFSI, the risk is less than significant per RG 1.91.

When using RG 1.91 approach for evaluating the risk of damage due to explosion from gas bottles transported in a truck, the estimates of parameters used for calculating exposure rate (r) are considered to be bounded by the estimates used for the 800-gallon truck explosion on the basis that:

n (explosion rate) is taken as the same as the 800-gallon truck since the primary reason for a bottle explosion is judged to be due to large truck crashes.

f (frequency of gas bottle shipments) is estimated to be four times a week or 208 times per year.

s (exposure distance in miles) is conservatively taken as the same as the 800 gallon truck hazard, although the potential energy release from explosion of a few gas bottles is significantly lower than the potential energy release from explosion of 800 gallons of gasoline.

Thus, r = (7.06e-10/mile) * 208 * 2300/5280 = 6.39e-8/year

Note: This is very conservative because we are assuming that all vehicle crashes lead to a bottle explosion.

There is one other potential failure mode for these pressurized bottles and that is a welded seam failure. Although this is a possibility, the gas bottles provided on the site are required to meet current industry testing standards. These standards are provided to ensure that a weld failure is not a significant risk.

Therefore, based on RG 1.91 criteria, the risk of damage due to gas bottle explosion is less than 1.0E-6 and is therefore considered insignificant.

Note that the risk of damage is a conservative measure to use as a surrogate for the risk to the public on the basis that the damage to the casks does not constitute failure of the cask barrier integrity or the fuel cladding integrity.

In addition to the transportation of gas bottles past the ISFSI facility, there is one stationary gas bottle facility along the transporter route that could potentially affect the transporter. This facility is located on the east side of the cold machine shop and contains acetylene bottles. This facility is more than twenty-five feet from the transporter route and is a few feet below the transport roadbed. The facility only holds a maximum of 10 bottles and is protected on two sides by concrete block walls and on the third side by a building. The Diablo Canyon procedural requirements for the storage of gas bottles ensure that these bottles are restrained in a vertical position ensuring that no potential missiles are aimed at the transporter route. These restraint requirements are provided for seismic considerations. In addition, the exposure time for the transporter being in the area is less than 10 hours per year.

Explosions or failures of any type involving compressed gas bottles usually are caused from valves being broken or the bottles being pierced by some external object. These types of failures require some motive force. The location of this facility provides limited access by vehicles and administrative controls will not allow any vehicle motion within 175 feet of the transporter, therefore, there is no motive force and the possibility of an explosion is not considered credible. The risk provided by this facility is conservatively bounded by the hydrogen facility risk potential.

RESULTS

The risks associated with explosions, which could potentially damage the HI-TRAC transfer cask or the HI-STORM storage cask and their associated SSC's, were evaluated. All the hazards evaluated resulted in conservative estimates for exposure rates of less than 10^{-6}, which is risk insignificant. According to RG 1.91, this risk level is acceptable.

The total risk potential for the Transporter is the sum of the risks that it will be exposed to as it moves along its travel route. To determine this total, the risk from the hydrogen facility and the parking lot vehicles are summed as follows:

Hydrogen facility (3.7e-7/year) + parked vehicles (6.18e-9/year) = 3.76e-7/year

The total risk potential for the ISFSI is the sum of the risks that it will be exposed to by hazards moving past it. To determine this total, the risk the gasoline powered vehicles and the gas bottles are summed as follows:

Gasoline powered vehicles (6.88e-7/year) + gas bottles (6.39e-8/year) = 7.52e-7/year

The total risk from all hazards result in risk rates of less than 10^{-6}, which is risk insignificant and according to RG 1.91, this risk level is acceptable.

RECOMMENDATIONS

Each of the assumptions listed in the assumptions section of this calculation should be implemented through administrative procedures. This is being tracked by AR A0524878.

REFERENCES

1. "Regulatory Guide 1.91, Revision 2, "Evaluation of Explosions Postulated to Occur On Transportation Routes Near Nuclear Power Plants," February 1978.

2. PG&E Calculation M-1046, Revision 0, "Minimum Separation Between Fuel Tanks and Storage Casks."

3. PG&E White Paper, "Bulk Hydrogen Facility Risk Evaluation," Doug Spaulding, dated February 2001.

4. "Evaluation of the HI-TRAC Transportation Route", Dave Hampshire, dated March 6, 2001.

5. EPRI, "Fire Events Database for U.S. Nuclear Power Plants."

6. US Department of Transportation, National Highway Traffic Safety Administration (NHTSA), "Traffic Safety Facts 2001," "2001 Motor Vehicle Crash Data from FARS and GES". http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/TSFAnn/TSF2001.pdf

7. US Department of Transportation, Federal Motor Carrier Safety Administration (FMCSA) "Large Truck Crash Facts 2001", January 2003 http://ai.volpe.dot.gov/CarrierResearchResults/PDFs/LargeTruckCrashFacts2001.pdf

8. PG&E Calculation M-1047, Revision 0, "Minimum Separation Between Acetylene Tanks and Transfer Casks."

9. "Telecon with Lou Ricks on Fuel Truck Size and Frequency, and Gas Bottle Size and Frequency" Philippe Soenen and Lou Ricks, 06/05/03. Attachment 1

10. IEEE Std. 500-1984, "IEEE Guide to the Collection and Presentation of Electrical, Electronic, Sensing Component, and Mechanical Equipment Reliability Data for Nuclear-Power Generating Stations."

11. Army TM 5-1300 – Structures to Resist the Effects of Accidental Explosions, November 1990, page 2-57.

12. PG&E Letter DIL-03-010, "Additional Question Related to Supplemental Blasts and Explosions Responses to Additional NRC Questions for the Diablo Canyon Independent Spent Fuel Storage Installation Application (TAC No. L23399)," dated July 28, 2003

"Telecon with Lou Ricks on Fuel Truck Size and Frequency, and Gas Bottle size and Frequency" Philippe Soenen and Lou Ricks, 6/5/03

In a discussion between Philippe Soenen, Licensing Engineer, and Lou Ricks, Garage Sub Forman, on the size and frequency of fuel trucks and gas bottles passing by the ISFSI site, the following was stated:

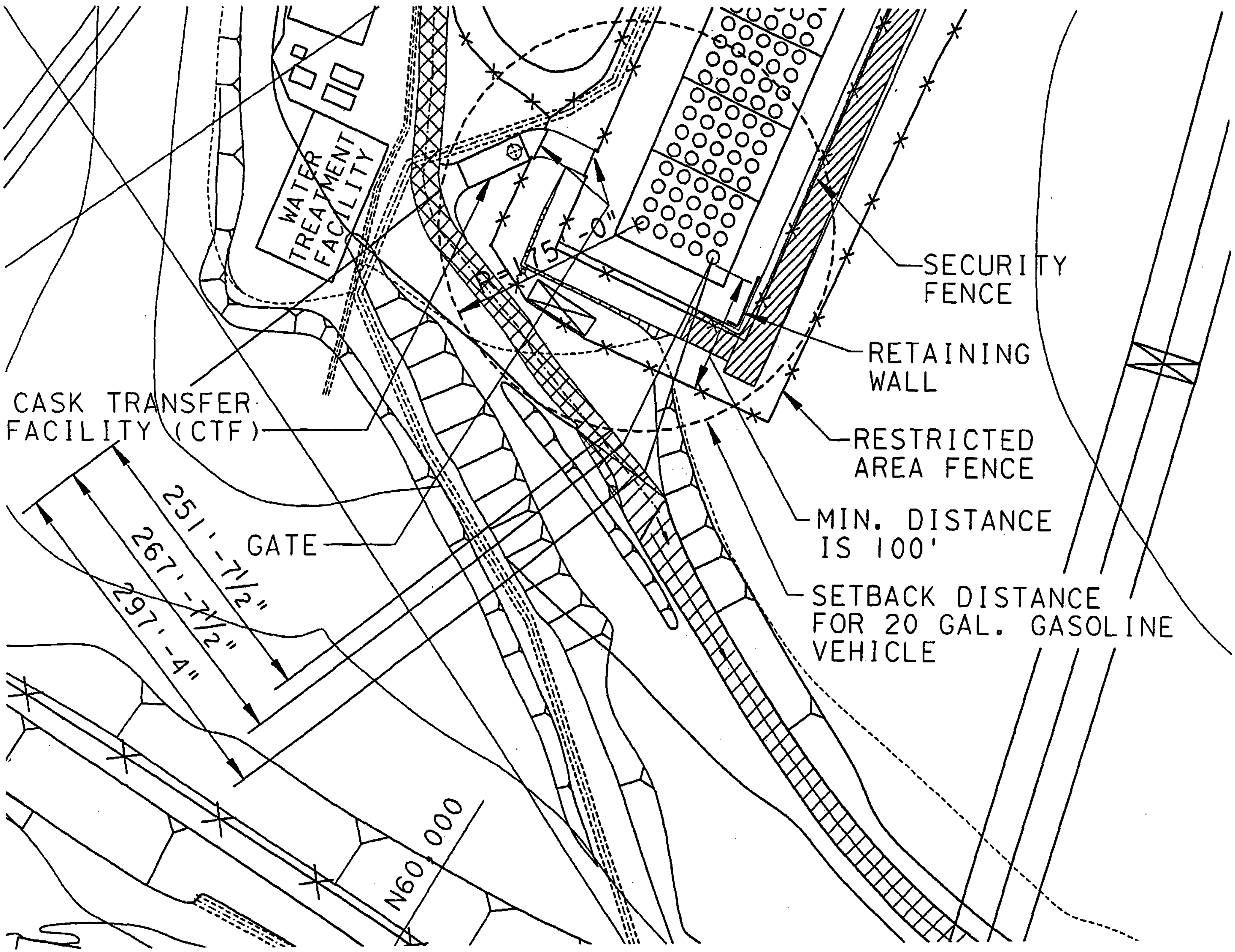
The 2,000-gallon gasoline fuel-tanker truck no longer goes past the ISFSI site. There is now an 800-gallon gasoline truck that passes by the site, on average, 6 times per week.

The only time propane bottles pass by the ISFSI site is when a forklift is traveling past the site or if a spare propane bottle for a forklift is brought to the Maintenance Shop.

On average, a forklift makes goes past the ISFSI site 4 times per week.

All of the propane bottles have a volume of 7 gallons.

The only other potential explosion hazard compressed gas bottle that is brought by the ISFSI site is an acetylene gas bottle for a cutting torch. A new bottle is taken up to the Maintenance Shop about once every four years.


WATER TREATMENT FACILITY
75'-0"
SECURITY FENCE
RETAINING WALL
RESTRICTED AREA FENCE
CASK TRANSFER FACILITY (CTF)
MIN. DISTANCE IS 100'
GATE
SETBACK DISTANCE FOR 20 GAL. GASOLINE VEHICLE
251'-7½"
267'-7½"
297'-4"
N60,000